POWER PLANT ENGINEERING

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Feminine Resonators

AMONG THE VARIOUS recent developments of the Westinghouse research engineers, the most attractive perhaps are the rather unusual electromagnetic resonators shown above. These resonators, it is quite apparent, differ considerably from the conventional open or closed resonators used in high frequency work; indeed they can hardly be classified in the conventional way. Now, don't jump at conclusions—we wouldn't for the world imply that these nice young ladies are not conventional, but it is quite evident that even in the Westinghouse laboratories, their role as resonators was enough of an occasion to have a photograph made of it.

The light, you will note, requires no electric current other than that furnished by the young ladies. This in our opinion would not be surprising, even if there were no other factors involved, but it so happens that they are standing in the ultra, high frequency electromagnetic field produced by a 15,000-watt standing wave oscillator. This tremendous field, alternating one hundred million times per second, lights up all lamps within a radius of 40 ft., cooks food in a matter of seconds and raises the body temperature one degree per minute. In the picture, H. V. Noble, research engineer, hurriedly explains the phenomena to the girls because after a few more minutes in the field's influence, they too would feel "lit".

So much for that. Quite apart from types of high frequency radiations which heat up young ladies are the still higher frequency radiations encountered in boiler furnaces. When we hear of frequencies of one hundred million cycles per second used in radio we are quite amazed, yet the type of radiation involved in the operation of radiant-heat superheaters have frequencies enormously higher—ten trillion cycles or more. The reason for our difference in attitude in these two forms of radiation is that we do not measure furnace radiation in terms of cycles but in degrees. Regardless of how we measure them advances in furnace radiation are shown on page 128 of this issue.

With the Editors

Cooperation Needed Against Government Control

No matter what our particular niche in the affairs of the world may be, we are all human and what we do ties in more or less intimately with other humans about us. Engineers have confined their attention, perhaps too closely, to their machines, the exact sciences and economical production and have left too completely to others the conduct of affairs which have to do with human relations and problematical questions—such sciences as psychology, sociology, economics. As a result, engineers are given the blame for the present condition of technological unemployment and have had heaped upon them many unjust criticisms.

If the engineer has developed machinery which necessitates only half the people to operate it that were required to supply the demand for goods a few years ago, the sociologist and economist have failed to keep abreast of modern advancement, if human beings are in need of the comforts of life.

It seems a perfectly logical deduction that a reduction in hours of human work and an equitable distribution of compensation would be the solution to any technological unemployment problem. But can such an apparently simple solution be put into effect? Industrial and financial institutions, labor organizations, political bodies, peoples of geographic divisions as well as individuals all set about to place themselves in the best possible position, at even the slightest change in social structure.

So we have individuals vying with individuals, units of an industry competing with other units for supremacy and industrial groups striving against each other for advantages. The strife is on and engineers, power plant engineers if you please, must take their part.

First of all, it must be recognized that, from a technical standpoint, engineers in all power and steam generating plants are faced with common problems of operation and construction and should be grouped together more intimately than they are. Adjustments are, of course, inevitable but unquestionably a more cordial and intimate relation between the managers and operating forces of industrial and public utility plants would clear up many of the technical problems in the generation and use of power and much of the misunderstanding relative to service, rates, interconnection and interchange of power among stations of all classes.

Unfortunately, no single organization seems at present to be so constituted as to undertake fostering such coöperation. The National Electric Light Association has done exceedingly fine work for the utility interests but has shown little inclination to reach an economic solution of power problems in various industries. The National Association of Power Engineers is composed largely of men charged with responsibility for plant operation, both utility and industrial. Certain members of the American Society of Mechanical Engineers have interested themselves in the technical as well as the commercial phases of the power industry. The common ground, however, on which all engineers interested in power generation, owners of power plants, users of power in large quantities and utility representatives can get together has not been established. When such an organization can be brought into functioning, much will be accomplished toward securing more satisfactory and economical power and service.

Through such an organization, a united effort could be made to prevent using the power industry as a political issue, the intent of which is always to extend the power of government over the industry. The result of such extension would inevitably be that the user of large amounts of power would pay more for his power than a just proportion of the cost of service. This extra cost under government control might in many cases be a deciding factor between purchasing power and investing in a generating plant, so that a stand against the meddling of government in the power industry is a problem of common interest to all engineers and industrial men desirous of obtaining economical power, as well as those who supply equipment for generating, distributing and utilizing power.

Irony in Engineering

"If Austria did not exist, it would be necessary to invent it," said a famous European statesman, in connection with a discussion of the organization of Europe, in which the great bloc under the rule of the Hapsburgs constituted an economic, political and ethnic unit that had to be reckoned with under one name or another. Similarly, if Dr. Diesel had never lived, it would probably have been necessary to invent an engine extremely similar to his, and at about the same time, according to H. R. Ricardo, in a speech before the Royal Society of Arts, as reported by Engineering.

The Diesel engine, still in its infancy, has developed, said Mr. Ricardo, to its present position largely because of the large amount of intermediates made available by oil refiners in the development of petrol (gasoline) to meet the demand created by the automobile. These intermediates could be burned under boilers, it is true, but were so unstable that they could not be used in any engine that required an external vaporizer. Thus the conditions were right and the need for such an engine as the Diesel was urgent.

It is ironical that while Dr. Diesel was not successful in his primary object of making an engine that could burn coal directly, this same engine turned out to be a good oil engine. The irony is augmented by the astonishment and interest that greeted the recent announcement that considerable work had been done in developing a Diesel engine to burn pulverized coal instead of oil.

With development of such an engine arises an interesting speculation as to the- relative economy of burning pulverized coal in a boiler furnace and in a combustion engine. Perhaps the answer will be boilers for large powers, the combustion engine for small powers. The dividing line for economy will be settled by experience

Suggestions for Profitable Reading

Engineering Services for Euclid Plant of Chase Brass & Copper Co.

How many industrial power engineers have wished that they could some day have a whole new power system, new right from the ground up, with no necessity for the constant battle with replacement and maintenance of old equipment nor with the problem of hooking on new stuff to the old, keeping everything running meanwhile. Well, let them gaze with envy on Chief Engineer Moody, in charge of the brand new power equipment of the Euclid plant of Chase Brass & Copper Co.

It is described in detail in this issue because by study of a new plant, having the latest practice in methods and equipment, the engineer should find some ideas that he can adapt to his own plant.

Proper Use of Steam, Power, Compressed Air, and the Like Is a Means To an End

Strictly from the standpoint of economics, the entire power business is carried on not as an end in itself but as a means to an end—the production of goods for human use. Engineers charged with supplying these services have many problems in common, whether they are in central stations or industrial plants; belt conveyors, for example, for handling coal, process materials, parts of equipment on the production line. Whatever the uses in his plant, every power engineer will be helped in operating by some knowledge of why they are designed as they are, discussed by Mr. Medley in Notes on Belt Conveyor Design.

In the article Economy in Small Plants from Modern Equipment, in this issue, it is shown how replacement of five old type boilers in a plant selling steam for heating by modern stokered water-tube boilers was found to give 50 per cent increase in rated capacity (page 117). With new boilers forced, output from the same space was trebled. While investment was increased 40 per cent, revenue was increased and total costs reduced so that net income rose 75 per cent. This striking instance of the benefits from modernization emphasizes the desirability of studying all present equipment to determine the possibilities of cutting expenses, increasing capacity and getting in shape for future demands, now while changes can be made at minimum first cost.

In his article entitled Steam Accumulator Reduces Installed Capacity and Increases Power, Mr. Sandberg shows how exhaust steam, from the high-pressure generating unit is passed to the accumulator, thence to process mains or to a low-pressure turbine, added steam needed being supplied to the accumulator through a pressure-reducing valve direct from the boilers. Firing is regulated to hold accumulator pressure within desired limits, the result being steadier boiler output and pressure, also steadier steam pressure at process equipment.

By study of heat balance and by driving the boiler feed pump with a low-pressure turbine taking steam from the accumulator at 40 lb., an extra 200 kw. was generated in the high-pressure unit and 300 kw. more in the low-pressure unit, a total gain of 500 kw. in output. These results, described on p. 118, are typical of savings that can be effected where conditions are suitable for steam accumulator application.

Although the convection superheater is still the most common type used, recent developments have shown that for certain conditions the radiant type possesses many advantages. To keep readers abreast of the latest findings is abstracted in this issue a paper that won the A. S. M. E. Junior prize last year and that brings up to date all the knowledge we have of the radiant superheater.

Welding—A New Tool of Industry for Construction and Upkeep

Importance of Oxy-acetylene Welding is discussed in considerable detail in an article giving several interesting instances of pipe line repair, engine repair and other work about the plant performed under difficult conditions at low cost. In another article on welded condensers, Mr. Graham shows how decrease in weight of the entire unit, formation of leak-proof joints, ease of fabrication and other benefits resulted from the use of welding in putting a large condenser together. Every engineer will find welding a useful tool.

Electrical Problems Are Common to All Plants, Either Generating or Purchasing Power

In an interesting article in the November 1, 1931 issue F. O. Wallene showed how purchased power and heating load demands in a milk plant are correlated to limit power demands and reduce costs. To show exactly how the equipment functions, Mr. Wallene in this issue explains in complete detail the construction and operation of the control device that keeps the power load and process steam pressure within determined limits.

Care and Operation of Power Transformers, are of common interest to all power men, in industry or central station. An article giving complete, detailed rules for care and operation of this vital part of the plant equipment, tells the engineer just how to inspect the units, how to dry core and coils, test oil and provide proper water circulation. It will be found on p. 125.

Parallel operation of alternating-current generators, while simple enough in its external aspects is fundamentally a complex and involved electrical problem and it is to the advantage of every operator to know why and how generators operate in synchronism. Mr. Stivender presents part three of a series of articles on this subject. In this particular article are discussed the factors that determine the value of the coupling angle. An operator should know these factors for that enables him to judge just how far he can vary the voltage of his generators for a given variation of bus voltage. The article, by the way, is much easier to understand than one would imagine from its appearance.

POWER PLANT ENGINEERING February 1 1932

Engineering Services f Chase Brass &

By C. B. SLATER

Chief Engineer, Chase Brass & Copper Co. Waterbury, Conn.

Extensive Distribution System for Steam, Air and High-Pressure Water, Control Room for Distributing Purchased Power, Boiler House and Water Supply System Form Principal Items in Well Developed Engineering Scheme

PLANNING the power, steam and general engineering services for its new plant at Euclid, Ohio, the Chase Brass & Copper Co. made a careful study of the present needs of the plant and of possible future requirements to keep pace with developments both in the processes themselves and in the power engineering field. As a result, the company has built a modern, scientifically designed factory at Euclid to manufacture its brass and copper products and for this factory has provided engineering services designed to insure low costs of steam, power and water to the processes throughout the life of the equipment.

In general, the power equipment consists of a boiler room, an outdoor substation, through which purchased power is brought into the plant, an electrical control room from which electric power is distributed to the processes, a water supply system including equipment for high-pressure water supply and a comprehensive distribution system for all these services to the processes, including a pipe tunnel. General arrangement of these elements is as shown in Fig. 3.

General Arrangement of Power House

The factory building itself is a brick and steel structure 1000 ft. long and 450 ft. wide, with a saw-tooth roof. Opposite the east end of the building is the power house, from which a tunnel 10 to 14 ft. wide and 8 ft. high, running the whole length of the manufacturing building along one side, carries the steam, air and water piping to supply the processes. Behind the power house is the water filter and storage pond for the entire plant, to which water is pumped through a pipe line 2 mi. long from a remote controlled pumping station on the shore of Lake Erie. The power house contains at present a boiler room, electrical control room and space for future installation of power generating equipment, although at present all electrical power is purchased.

Future expansion of the manufacturing plant will be possible by building one or two more manufacturing units alongside the first one. The power house will then be approximately at the center line of the group and tunnels can be conveniently run from it to the manufacturing buildings to carry piping for steam, air and water. Since progress may be expected both in manufacturing technique and in distribution of mechanical and electrical services, this unit expansion will permit new developments to be utilized with the least trouble and without necessity of revamping all the services of existing units.

Boilers and Auxiliaries

In the boiler house, at present, three bent-tube three-drum boilers of 5000 sq. ft. surface each, designed to produce a maximum of 37,500 lb. of steam an hour each, at 200 lb. gage pressure, are installed. The boiler room is laid out with space available for another similar boiler unit when it is needed. Convection type superheaters in the first pass of each boiler are designed to produce a total steam temperature of 540 deg. F. These boilers are fired by five-retort underfeed stokers driven by steam-turbine stoker drives. Furnaces have water-cooled back walls and refractory side walls, with air-cooled refractory blocks in the lower sections of these side walls.

No economizers are used with these boilers but heat from the flue gas is recovered by air preheaters, one preheater per boiler, each having 4000 sq. ft. of air heating surface. These are designed to produce a combustion air temperature of 300 deg. F. at 100 per cent of rating and 375 deg. F. at 200 per cent of rating. Forced draft fans supply combustion air through the air preheaters to the stokers and induced draft fans remove flue gas, discharging it through an individual steel stack over each boiler. Forced draft turbovane fans, one per boiler, are rated at 19,400 c.f.m. each of 80 deg. air at 3.24 in. static water pressure. These fans are driven at 2000 r.p.m. by 25-hp. steam turbines. Multivane induced draft fans, one per boiler, are each designed for a capacity of 33,000 c.f.m. of flue gas at 640 deg. F. to produce 1.3 in. static water pressure when driven at 485 r.p.m. by 17-hp. steam turbines. Speeds of these draft fan turbines, as well as of stoker drive turbines, are handled by means of a combustion control system. To control conditions in the furnaces, dampers in the forced draft air ducts are adjusted by a combustion regulator on each boiler.

For the guidance of the boiler operator a panel board for each boiler, mounted on the floor beside each stoker, carries a boiler meter, indicating steam pressure gage, temperature recorder for recording combustion air tem-

s for the Euclid Plant of the s & Copper Co.

Fig. 1. Boiler Room Contains Three Stoker-Fired Boilers Equipped with Air Preheaters.

perature and a coal feed indicator driven from the stoker drive.

Coal and Ash Handling Equipment

Coal is stored in a 424-t. storage pile behind the plant from which it is reclaimed by a locomotive crane. This crane loads coal to a track hopper, whence it is fed by a belt feeder to a 50-t.-an-hour crusher in a pit below the boiler room floor. After it is crushed, a bucket elevator conveys it to a belt conveyor running over the 300-t. overhead steel-plate bunker in the boiler house. A tripper is used on this belt conveyor to distribute the coal in the bunker. From this bunker it feeds to automatic coal scales, then through nonsegregating coal spouts to the stoker hoppers. An automatic coal scale on each boiler records the weight of coal passing to the stoker.

The stokers are equipped with hydraulically operated ash dumps and the ash is dropped from these into hoppers from which it is discharged through ash gates to industrial cars that remove it from the plant for further disposal.

Closed Boiler Feedwater Cycle

For furnishing makeup water to the boilers, the modern scheme of closed feedwater circuit is used, employing an evaporator to generate low pressure process steam. This idea has been used successfully by a number of central stations and industrial plants, with the object of feeding the boilers with nothing but evaporated water to reduce scale and deposits in the boilers, thus lowering maintenance costs.

Steam generated by the boilers at 200 lb. pressure is utilized in the heating system, for process work and for water heating. For processes and heating system, steam pressure is reduced to 100 lb. by reducing valves and distributed at that pressure. Steam used in process work is not returned to the boiler house, of course, but all condensate from the heating system is collected in a tank in the mill from which it is pumped to a hotwell in the boiler house, where it forms the bulk of the makeup

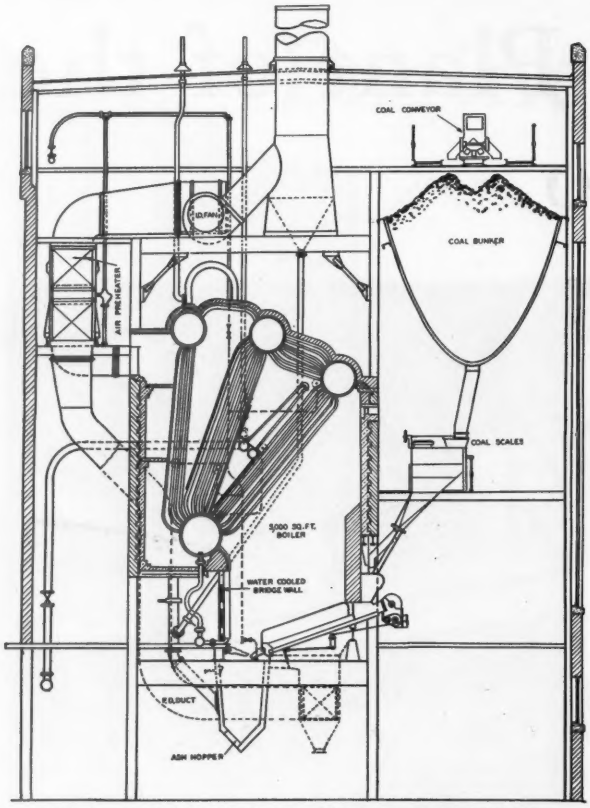


FIG. 2. CROSS-SECTION THROUGH BOILER ROOM

water. When the heating load is light, only a small amount of condensate is thus returned to the hotwell and, to supply the additional amount needed in this case, a 20,000-lb.-an-hour bent tube evaporator is installed.

This evaporator takes steam at 200 lb. pressure from the main steam header and evaporates raw water from the general mill service supply into 100-lb. steam for the processes and necessary heating. The 200-lb. steam is condensed in the evaporator and the condensate goes to the hotwell for boiler feed. Evaporator feedwater is heated by steam in an open heater of 20,000-lb. per hr capacity from 50 deg. to 200 deg. and is pumped to the evaporators by 50-g.p.m. motor-driven centrifugal pumps. A regulating valve controls the amount of 100-lb. steam produced by the evaporator to correspond with the process steam demand.

Feedwater from the hotwell is sent to the boilers by three centrifugal boiler feed pumps, each rated at 185 g.p.m. capacity at 517 ft. head, two driven at 2700 r.p.m. by 50-hp. steam turbines and one driven at 1750 r.p.m. by a 50-hp. motor. By suitable combinations of these pumps, the heat balance may be maintained so that the proper amount of exhaust steam may be supplied for feedwater heating.

Heating of Boiler Feedwater and Mill Service Water

Before entering the boilers, this feedwater is heated to about 215 deg. in two closed heaters of 90,000 lb. an hour capacity each, connected in parallel and supplied with steam at 5 lb. gage pressure from the exhaust of turbines driving fans, stoker turbines and turbines of service pumps. Boiler feed pumps are under control of pump governors and feedwater temperature, steam pressure and feed water pressure are recorded by a recording instrument.

Hot water for use in the mill is heated in the boiler house to 200 deg. by a 102,000-lb.-an-hour closed heater taking steam at 5 lb. pressure from auxiliary exhaust main.

General Water Supply System

All water used in the boiler house, as well as that used in the manufacturing processes, comes from the central water supply reservoir behind the power house, as shown in Fig. 3. Water is pumped from Lake Erie, two miles from the plant, through a 30-in. cast-iron pipe line. A pump house on the lake shore contains two 6000-g.p.m. centrifugal pumps driven by 350-hp. motors, remote controlled from the control room in the boiler house. Total water demand of the entire factory and boiler house is about 300,000 gal. a day. Water is

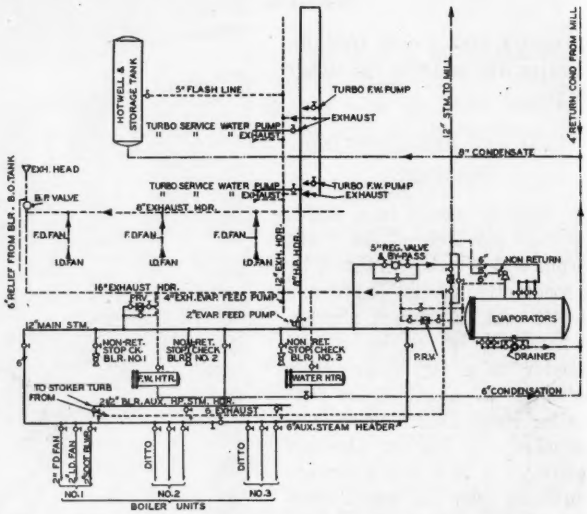


FIG. 4. DIAGRAM OF STEAM FLOW IN BOILER PLANT AND SUPPLY TO MILL

pumped to a 1,000,000-gal. settling basin. Just before the water enters this settling basin, it is treated with alum. It is then filtered in a sand filter of 3000 g.p.m. capacity, then treated with chlorine by a chlorinator and finally flows to a 100,000-gal. clear well.

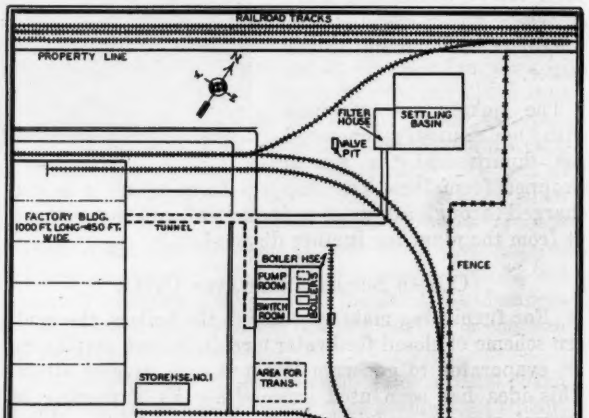


FIG. 3. GENERAL ARRANGEMENT OF EUCLID PLANT

Principal Power Equipment—Euclid Plant of Chase Brass & Copper Co.

Power House

Boilers, 3 Connelly type units, 500-hp. each—with superheaters	Foster Wheeler Corp.
Air preheaters	Foster Wheeler Corp.
Stokers, 5-retort under feed	Westinghouse Elec. & Mfg. Co.
Forced and induced draft fans with turbine drives	B. F. Sturtevant Co.
Combustion control equipment	Hagan Corp.
Coal-handling and storage equipment	Industrial Brownhoist Co.
Coal scales	Richardson Scale Co.
Coal spouts, Non-Seg	Rolland Gardner Co.
Boiler feedwater regulators (Copes)	Northern Equipment Co.
Boiler meters, flow meters, draft gages	The Bailey Meter Co.
Boiler settings with Connelly water-cooled back walls and Drake blocks on side walls.	Drake Non-Clinkering Furnace Block Co.
Indicating pressure and temperature gages	Bailey Meter Co.
Recording pressure, temperature and other gages	The Bristol Co.
Coal feed indicators for stokers.	Westinghouse Electric & Mfg. Co.
Soot Blowers	Diamond Power Specialty Co.
Water Columns	Reliance Gauge Column Co.
Water Illuminators	National Co.
High pressure steam and water piping	National Tube Co.
High pressure steam and water valves	Walworth Co.
Blowoff valves	Yarnall-Waring Co.
Bent-tube evaporator, 20,000 lb. an hr. cap.	Griscom-Russell Co.
Heaters for boiler feedwater, service water, evaporator feedwater	Griscom-Russell Co.
Boiler feed pumps, evaporator feed pumps, service pumps, (All Cameron, two boiler feed pumps and two service pumps driven by Westinghouse turbines, others by G.E. motors).	Ingersoll-Rand Co.
Hydraulic pumps, 600-lb.	The Aldrich Pump Co.
Hydraulic pump, 6000 lb. G.E. synchronous motor drive	Worthington Pump & Machinery Corp.
Air compressors, G. E. motor drive	Ingersoll-Rand Co.
Pump governors	Fisher Governor Co.
Evaporator regulating valves	Fisher Governor Co.
Steam reducing valves	Atwood & Morrill
Steam traps	Strong, Carlisle & Hammond Co.
Distribution meters, steam, air, water, etc.	Bailey Meter Co.
Driving motors	General Electric Co., Reliance Elec. & Eng. Co.
Motor controls	General Electric Co. Westinghouse Elec. & Mfg. Co. Cutler-Hammer, Inc.
Building steel	Austin Co.
Gratings and stairways	Tri-Lok Co.

Water Supply System

Centrifugal pumps, 6000 g.p.m. each with motor drives	Ingersoll-Rand Co.
Piping, valves, etc	Walworth Co.
Meters and instruments	Builders Iron Foundry
Sand filter, 3000 gal. capacity	Hungerford-Terry Co.
Chlorinator	Wallace & Tiernan Co.

Electrical Equipment Both in Power House and Factory

Main control board in control room and D. C. boards in Mill	General Electric Co.
Truck Type Switching Equip.	Westinghouse Elec. & Mfg. Co.
Transformers, switches, lightning arrestors in substation	General Electric Co.
Conduit and wiring	Grant Electric Co.
Lighting fixtures	Holophane Co. through the Hessel-Hoppen Co.
Motor control equipment	General Electric Co. Westinghouse Elec. & Mfg. Co. Cutler-Hammer, Inc.
Motor-generator sets	General Electric Co.
Motor driving process equipment	General Electric Co. Reliance Elec. & Eng. Co.

Other Service Equipment in Mill

Cranes	Harnischfeger Sales Corp.
Hoists	American Engineering Co.
High-pressure water piping, Compressed air piping	National Tube Co.
Steam and water valves	Walworth Co.
Unit heaters	York Heating & Ventilating Corp.
Steam traps	Strong, Carlisle & Hammond Co.
Sump pumps, return pumps	Worthington Pump & Machy. Corp.
Speed reducers	Horsburg & Scott
Conveyors	Industrial Broomhart Corp.

High Pressure Water and Compressed Air Supply

The boiler feed pumps and evaporator are in the boiler-room basement, where also are located the water pump supplying 600-lb. pressure water to the mill, two air compressors for supplying general service air and the mill service water pumps. The high-pressure water pump is a vertical triplex unit of 60 g.p.m. capacity at 600 lb. pressure, driven at 60 r.p.m. through gearing by a 25-hp. motor.

Two 1600-c.f.m. two-stage air compressors, driven at 225 r.p.m. by 300-hp. synchronous motors compress air

FIG. 7. TWO MOTOR-DRIVEN CRANK AND FLYWHEEL PUMPS IN MILL SUPPLY WATER AT 6000 LB. PER SQ. IN. FOR A PROCESS MACHINE

to 100 lb. for distribution to the plant through the tunnel to be described later and for general use about the power plant.

Three 3000-g.p.m. centrifugal pumps, two driven by steam turbines and one by a motor, supply water to the mills for general service at 60 lb. pressure. These pumps are in the boiler house basement. Amounts of steam, compressed air, and hot and cold water to the factory are recorded by flow meters, while recorders give data on pressures and temperatures, thus providing accurate records from which costs may be determined.

Electric Power Supply

No generating equipment is installed in this power plant at present but space has been reserved for it in the power house in case future developments should make it advisable to generate power. The space left for possible future generating equipment is occupied now by two 360-kw. motor-generator sets.

All electric power used in the plant at present is purchased from the Cleveland Electric Illuminating Co. It enters the outdoor substation at 33,000 v., where it is stepped down to 4600 v. by one bank of 33,000/4600-v. oil-insulated self-cooled transformers, rated at 7500 kv-a.

The outdoor substation is of the standard structural steel type and this particular unit has a capacity of two banks of transformers, the second bank to be of 7500-kv-a. capacity or larger if desired.

The substation is fed by two 33,000-v., 3-phase, 60-cycle lines from a tap tower on the utility company's main line from this East Cleveland station and the substation is equipped with transfer bus so that these feeders can be operated singly or in parallel as desired and with the necessary disconnecting switches for making

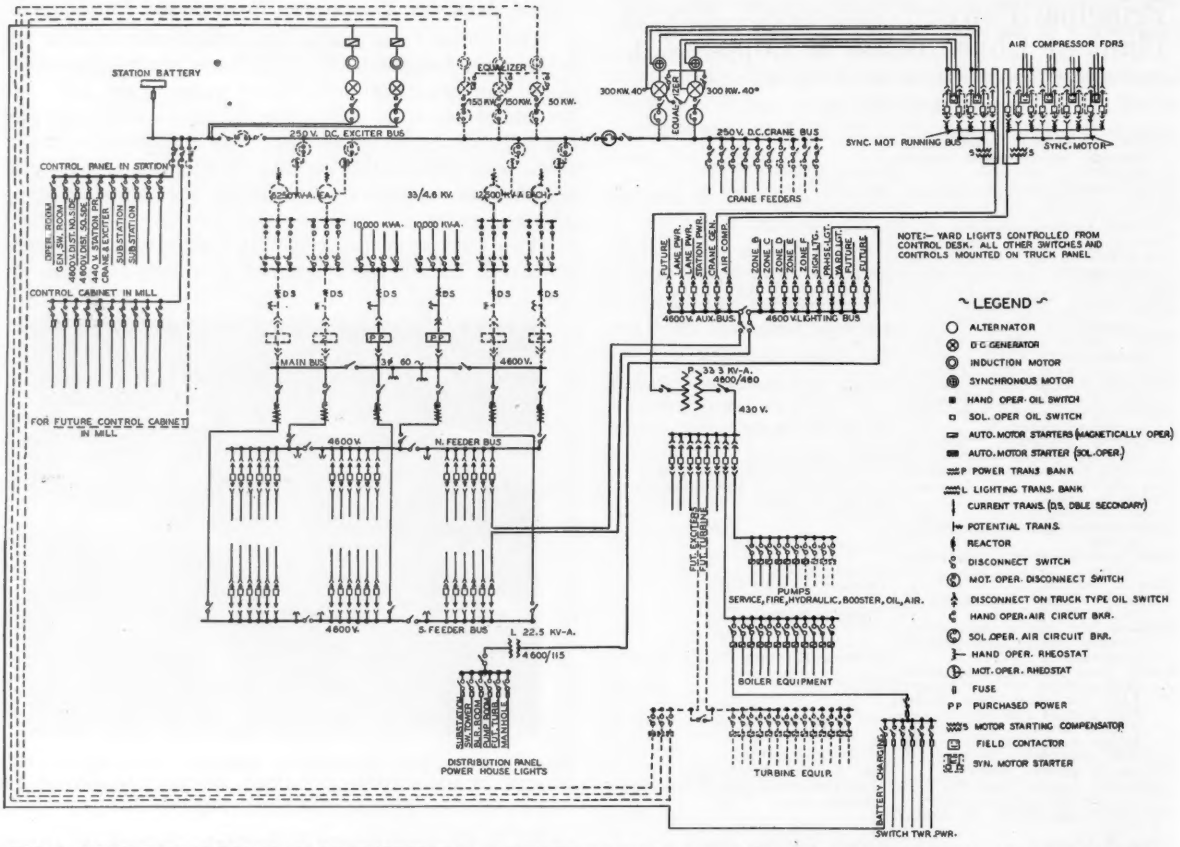


FIG. 5. SINGLE-LINE DIAGRAM OF ELECTRICAL CIRCUITS IN EUCLID PLANT SHOWING CONTROL OF AUXILIARIES AND MILL EQUIPMENT

this transfer. For protection from lightning, the Type O F, Form B O, oxide film lightning arresters are installed.

This 4600-v. power is distributed to all circuits from a large control room on the second floor of the power

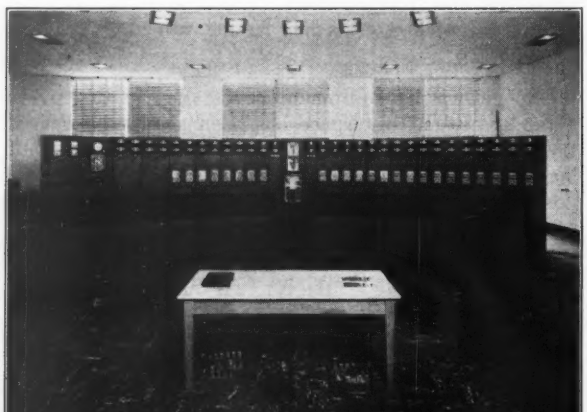


FIG. 8. ALL ELECTRICAL CIRCUITS ARE CONTROLLED FROM THIS ROOM

house. All motors above 100-hp. capacity are wound for 4600 v. while those smaller than 100-hp. operate at 440 v. obtained from four banks of transformers of 1000 kv-a. capacity each, located in transformer rooms off the tunnel in Mill Bldg. in about the center of distribution of four equal zones. The control room contains a semi-circular bench board with instrument panels behind it, Fig. 9, similar to the type of controls often used in central stations. This board carries meters and switches for each out-going 4600-v. and 440-v. feeder circuit.

The two secondary circuits are brought in from the substation at 4600 and connected to the main bus through two solenoid-operated, truck-type switches and arranged so that these circuits can be operated singly or in parallel as desired. To this main bus is connected the 4600-v. truck type feeder switches that distribute the current to the different load centers throughout the mill. These truck type switches are controlled from the main control board located on the third floor of the control tower.

Panels on the control board for the purchased power circuits are equipped with the usual meters to be used for billing purposes and necessary relays for protecting the circuits, each feeder panel being equipped with indicating ammeter, wattmeter, recording watthour meter and necessary relays for protecting the circuit.

Provisions are also made on this board for the control of generators should the company find it necessary to install them at some future time.

In this control room is also located a direct-current switchboard for the control of two motor-generator sets used for generating direct-current power for crane service, also for distributing this current to the different crane runways in the mill building.

The alternating current motors in the mill up to and including 100 hp. are operated at 440 v., 3-phase, 60-cycle this current being taken from four transformer banks located approximately in the center of the four zones.

Motors above 100 hp. are operated at 4600 v., 3-phase, 60 cycle to save line and transformer losses from these larger units. In most cases the larger motors are of the synchronous type, because the brass mill load is extremely variable, resulting in a poor power factor. The synchronous motors are used for correcting this power factor, which, up to this writing, the plant is enabled to maintain an average of 98.5 per cent power factor.

The four 750-kw. and one 1000-kw. motor-generator sets located in three different zones in the mill generate direct current at 250 v., which is used for the variable speed work.

Tunnel and Distribution System

From the power house described above, all steam, water and compressed air piping are run to the plant in a reënforced concrete tunnel, in which the piping is installed overhead. For the various processes, branches from main piping are run up from the tunnel and are supported overhead on the building steel work, where they are easy of access for maintenance and for making connections.

Opening from the tunnel at various points are vaults containing motor-generator sets, transformers and electrical control equipment for the processes. Six large motor-generator sets, ranging in capacity from 750 to 1000-kw. capacity are installed here to supply 250 v. d.c. for process work. Operation of these units is governed from the central control room in the power house. Electric wiring, conduits, switches and control equipment distribute the power to the various machines and

FIG. 9. MOTOR-GENERATOR SETS IN ROOMS OFF TUNNEL SUPPLY DIRECT-CURRENT FOR VARIABLE SPEED MILL MOTORS

conveyors, which are driven by electric motors of various types and sizes.

Heating System

Steam at 100-lb. pressure for process work and for the heating system is distributed from the mains in the

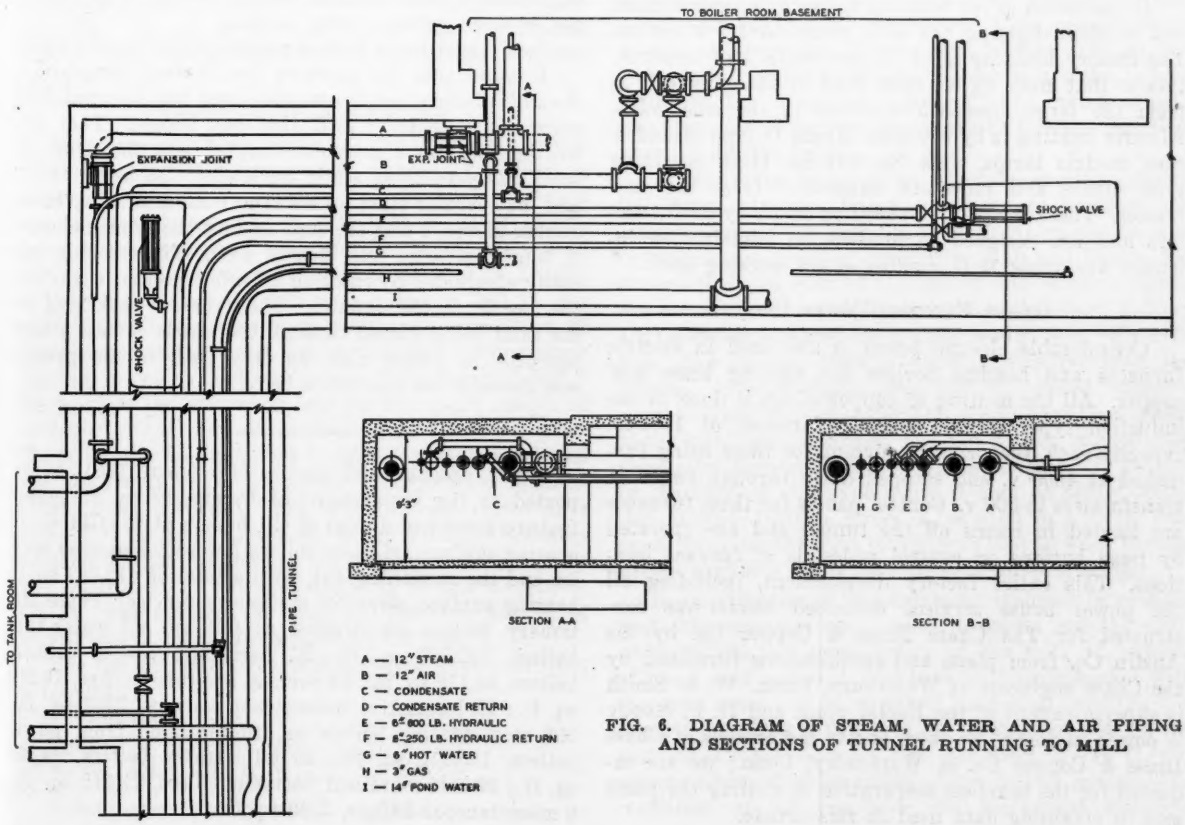


FIG. 6. DIAGRAM OF STEAM, WATER AND AIR PIPING AND SECTIONS OF TUNNEL RUNNING TO MILL

pipe tunnel through overhead lines, which are fitted with expansion bends. Compressed air lines also run overhead with suitable hose connections on the building columns.

Unit heaters suspended from the crane beams supply heat and ventilation for the working space. These heaters, each of 11,900 c.f.m. air capacity, are suspended about 7 ft. above the floor and supply heated air to about 547,400 cu. ft. per minute. Total heat output at 50 lb. steam pressure is 51,520,000 B.t.u. per hour. Condensate from these heaters is returned through steam traps to the condensate tank in the pipe tunnel, from which it is pumped by 200-g.p.m. motor-driven centrifugal pumps to the hotwell in the power house as noted above.

Water at 600 and 6000 Lb. Pressure

High-pressure water supply for process work is one of the most important services rendered by the power plant. Water at 600 lb. pressure for use on certain presses and other process equipment comes through the tunnel and is distributed through suitable hydraulic piping and fittings to the machines.

For one large machine, water at 6000 lb. pressure is needed. Since the water piping for this pressure would prove rather expensive if the high-pressure pump were placed in the power house, two pumps are located right at the machine itself. The pumps are horizontal duplex, crank and flywheel type units especially built for this service. They are driven at 450 r.p.m. by two 400-hp., 4600-v. synchronous motors the rotors of which are direct connected through flexible couplings to the pump crankshafts, as shown in Fig. 7.

Illumination of the working spaces by proper natural and artificial lighting has been given careful attention. The factory building is of the saw-tooth roof construction so that much light comes from overhead as well as from the large steel-sash windows in the side walls. Electric lighting is by 500-watt Mazda C type incandescent electric lamps, with No. 681-AL High mounting type shades and reflectors, suspended from the roof trusses. These lamps are spaced on 20-ft. by 25-ft. centers and are designed to produce an illumination intensity averaging 12 ft. candles at the working level.

Other Electric Power Uses

Considerable electric power is also used in electric furnaces and heating devices for melting brass and copper. All the melting of copper alloys is done in the induction type, electric melting furnaces of 1600-lb. capacity each, the primary current for these being furnished at 4600 v. and stepped down through banks of transformers to 500 v. Control panels for these furnaces are located in rooms off the tunnel and are operated by push buttons on control pedestals at furnace locations. This entire factory development, including all the power house services described above was constructed for The Chase Brass & Copper Co. by the Austin Co. from plans and specifications furnished by the Chase engineers at Waterbury, Conn. W. L. Smith is superintendent of the Euclid plant and H. F. Moody is power engineer. To them and to the officials of Chase Brass & Copper Co. at Waterbury, Conn., we are indebted for the heartiest coöperation in visiting the plant and in obtaining data used in this article.

An Unusual Static Charge

By Grady H. Emerson

STATIC ELECTRICAL PHENOMENA occur in a number of processes and in various manufacturing plants, particularly in grain handling machinery, paper manufacture and printing, textile mills, paint manufacture and gasoline handling. Almost any fast moving, dry belt will generate static. Static electricity will in some cases cause the breakdown of electrical equipment, if it is not reduced or removed before the voltage is built up high enough to puncture the insulation. Static electricity would not injure the machinery but the lower frequency current will follow and result in damage to the equipment. Static electricity is used also for various purposes and is very useful when controlled.

Not many weeks ago, one cold December night I was sent to a stove foundry. The complaint was that the lighting circuit was shocking the operator of a sand blast machine and it was impossible for him to do his work. More correctly, he was refusing to work in the blast enclosure. The sand blast equipment was modern in every respect and complete. The castings were placed on a rotary table and the sand was caught in a pit below. The air pressure used was about 80 lb. per sq. in. The sand was forced through an armored rubber hose and the end of this hose was equipped with a cast reducing nozzle. When I arrived on the scene, the plant mechanic, being unfamiliar with troubles of this kind, had disconnected all of the lighting equipment and tested it. None of it was found defective and he had instructed the workman to return to the blast, as there were several rush orders. The voltage was so high that the operator had wrapped several burlap bags around the hose to prevent being shocked.

In a few minutes he had complained of shocks again.

I found that the operator had started complaining the night before and the weather had just changed from warm to unusually cold the day before. This cool weather and dry atmosphere coupled with the clean dry sand was generating static electricity. To prove this, I had the operator start up his sand blast and using heavy rubber gloves, I shot the sand against the steel enclosure. A blue discharge was clearly seen. This trouble was easily eliminated by running a flexible ground wire from the nozzle to the ground. The friction generated by the sand being forced through the nozzle caused a high potential to collect and the only path to the ground was through the operator's body.

Steel boilers sold during November, 1931, as reported to the Department of Commerce by 73 manufacturers reached a total of 491 boilers of 424,044 sq. ft. heating surface. Of these boilers 7 were for marine service and the remaining 484, with a total of 412,737 sq ft. heating surface, were for stationary service. These stationary boilers are divided as follows: 42 water-tube boilers, 142,933 sq. ft.; 21 horizontal return tubular boilers, 26,119 sq. ft.; 54 vertical fire-tube boilers, 16,224 sq. ft.; 12 locomotive boilers, not railway, 7302 sq. ft.; 306 steel heating boilers as differentiated from power boilers, 180,910 sq. ft.; 23 oil country boilers, 24,895 sq. ft.; 20 self-contained portable boilers, 11,112 sq. ft.; 6 miscellaneous boilers, 3242 sq. ft.

Proper Belt Conveyor Tension Determination

COMPLETE FAILURE OF A BELT CONVEYOR INSTALLATION OR GREATLY REDUCED LIFE MAY RESULT FROM PROVISION OF IMPROPER COUNTERWEIGHT. BY HAROLD C. MEDLEY

BEFORE a belt conveyor can function properly, it must have an initial tension imparted to its belt. The amount of this tension is dependent upon two requirements. They are the tension necessary to produce traction between the belt and the driving pulley and the tension needed to keep the sag of the belt between the idlers within workable limits. The first—the tension necessary to produce traction—is the only phase of the subject treated in the handbooks published by builders of conveyors and manufacturers of belting. Nor are definite values of permissible sag furnished.

That such values are of real importance is evidenced by the fact that it was found necessary to more than double the counterweight on two heavy conveyors with which I have been acquainted within the past year or two before successful operation could be achieved. Another instance was the recommendation of one company in the case of the largest belt conveyor to be proposed in 1931 up to the time of this writing. This conveyor—now in the course of construction—is 60 in. wide, with idlers spaced 3 ft. 9 in. on centers, and is to handle material weighing 63 lb. per cu. ft. A 300-hp. motor is required for its tandem drive. This belt manufacturer in his recommendation specified the counterweight as nominal. A nominal counterweight would not produce sufficient tension to make this conveyor function satisfactorily. The sag of the belt at and near the loading end of the conveyor would have exceeded workable limits.

VALUES OF SAG PERMISSIBLE

Reference has been made to two conveyors whose counterweights were more than doubled in order to secure satisfactory operation. One of these conveyors was 48 in. wide and 610 ft. long with a lift of 142 ft. 6 in. It was equipped with anti-friction idlers spaced 3 ft. 6 in. on centers and a tandem drive with 150-hp. motor which drove the belt at a speed of 309 ft. per minute. While the average capacity was only 400 t. of bituminous coal per hour, yet intermittent loading made the rate at which coal was momentarily handled 550 t. per hr. and the maximum load on the entire length of conveyor at one time the equivalent of 475 t. per hour. The tail pulley was mounted in boxes sliding in machined iron guides and was connected to a 1000-lb. counterweight hung vertically. The take-up boxes rested on a slope of 7 deg. 15 min., and the entire tail shaft assembly weighed 3000 lb. Assuming the coefficient of friction of iron on iron at 25 per cent about ⅛ of this weight, or 375 lb., was required to move it. This left 625 lb. of counterweight useful for stretching the belt.

The design figures for this conveyor were somewhat as follows:

To run empty belt	9.3 hp.
To convey 475 t. 610 ft.	8.5 hp.
To lift 475 t. 142 ft. 6 in.	68.5 hp.
Total power through belt	86.3 hp.

Belt stress due to power only 86.3 × 33,000 ÷ 309	9200 lb.
Component of belt weight on slope minus friction	2040 lb.
Pull from effective counterweight 625 ÷ 2	312 lb.
Maximum stress in belt on tight side	11,552 lb.

Specifications for this belt stated that it was to work at 24 lb. per ply per inch of width. On this basis 10.03 plies were required and a 10-ply belt was used. For the loose side, the figures were as follows:

Component of belt weight on slope minus friction	1700 lb.
Pull from effective counterweight	312 lb.
Total loose side stress	2012 lb.

The explanation of the loose side component of the belt weight being 1700 lb. instead of 2040 lb. as on the tight side is that only 500 ft. of the return strand were on the slope while there were 610 ft. of the carrying strand on the slop. Attention is called to the fact that the loose side tension was 2012 lb. whereas a tandem lagged drive working on 9200 lb. power stress requires but 1150 lb. loose side stress in order to secure traction. In fact the component of the weight of the belt alone or 1700 lb. was ample for this purpose, and the counterweight was put on for other reasons. First, some counterweight was necessary to overcome take-up friction and keep the tail pulley back against the belt in order to take up slack due to stretch. Second, some counterweight was deemed necessary to stretch the belt across the idlers near the loading point.

At this point, however, an otherwise excellent design fell down. It was found necessary to increase the counterweight from 1000 lb. to 2500 lb. before the conveyor would operate satisfactorily. This additional 1500 lb. or 750 lb. in each of the loaded and empty strands, was necessary to stretch the belt across the idlers, making a total stress required for a fully loaded belt with 3 ft. 6-in. idler spacing 1062 lb.—213 lb. effective from the original counterweight plus 750 lb. added counterweight. Even more than 1500 lb. would have been added to the total counterweight, had not a floor immediately above the counterweight prohibited making it longer. In the light of this experience, it may be safely stated that at least 1060 lb. stress is required in a 48-in. conveyor fully loaded with bituminous coal to keep the sag within workable limits on 3 ft. 6-in. iidler spacing.

In amplification of this statement, it should be recalled that this conveyor was loaded in spots; but the spots occupied the full cross section of the belt. If, instead of being spot loaded, it had been uniformly loaded with the same cross section, it would have been carrying 550 t. per hour. This is full load for bituminous coal on the basis of $3.2\ W^2$ = cubic feet per hour at 100 ft. per minute when W is the width of the belt in inches. The coefficient of 3.2 has been the recognized standard

measure of belt capacity for many years. The trend, however, is now toward heavier loading of wide belts and a coefficient of 4 can safely be used for a 48-in. belt. But in the conveyor presented here, 3.2 had been the loading basis and the tension of 1060 lb. is only applicable to this loading. Had the belt been loaded to a coefficient of 4 an increase in tension would have been necessary.

Mathematical Expression for Sag

In order to apply the information gained from this example, it is necessary to reduce it to a mathematical expression. Therein an apparent difficulty is confronted. In the case of a troughed belt, a value for the sag of the belt as a whole in terms of belt tension and load cannot be directly determined as it could be in the case of a flat belt; for it is possible to lay a short piece of belt across two troughing idlers and load it lightly without appreciable deflection. If the belt were moulded to the troughed shape, its moment of inertia could be determined and its deflecting under load computed. Such a procedure cannot be followed in the case of a flexible belt constrained to a troughed shape by idlers. The belt is under lateral stress and tries to flatten out between the idlers of its own accord. This flattening tendency is greatly accentuated as the load is applied, increasing rapidly until a piece of belt otherwise unstressed will collapse abruptly at the center of the span, folding in a relatively sharp crease the moment the trough is completely lost.

The displacement of the edge of the belt does not occur vertically, but takes place substantially at right angles to the plane of the belt at its edge. This being the case, the trough—while it helps to prevent vertical displacement of the load—does not lend much assistance to the edge and we may consider the edge as a uniformly loaded string stretched across the idlers. Within the limits of error well within the accuracy of belt conveyor design, this departure of the edge of the belt from a straight line is directly proportional to the load on the belt including its own weight. It is also proportional to the span and inversely proportional to the axial pull. These statements are derived from the equation for determining the sag of a suspension cable uniformly loaded along the span; or

$$PL^2 \div 8S = D$$

when P = load per unit of length of span.
L = length of span.
S = stress in the same units as P.
D = sag in the same units as L.

This is the equation of a parabola and will be used for the sake of facility of computation. The true curve is a catenary, but permissible deflections are so small that the curves of the catenary and the parabola are almost identical. The true value of P is unknown, but it is proportional to the vertical load. Since we are interested in the setting up of a convention with which to compare one conveyor with another, the actual value of the force acting on the edge of the belt is of no importance if we know some other force to which it is proportional. The known force may be substituted in the equation and the result will be correct for use as a comparator. To give the result its absolute value, a proportionality constant would be required, but the determination of this constant is a refinement of which there is no need.

The known values from the specimen conveyor are:
S or belt tension = 1060 lb.
Weight of belt = 1.42 lb. per inch.
Weight of coal = 5.25 lb. per inch.
P = 6.67 lb. per inch.
L or idler spacing = 42 in.

Substituting these values, the equation becomes $6.67 \times 42^2 \div (8 \times 1060) = D$ or 1.39 in. sag. This value of sag is a convention in comparing conveyors. No such measurement could be made on the actual conveyor. But it does enable us to say that a conveyor with 3 ft. 6-in. idler spacing loaded and stretched in a manner which produces a result of 1.39 in. from a similar computation will be a tolerably satisfactory conveyor. That is, a computed sag of 1.39 in. is the maximum allowable for 3 ft. 6-in. idler spacing.

Total sag in an isolated case, however, does not furnish the required criterion. Sag is deleterious in that it permits the shape of the cross section of the load to change. A sag of 1.39 in. on an idler spacing of 3 ft. will be more harmful than the same sag on a spacing of 3 ft. 6 in. because the slope of the curve at the supports is steeper, permitting the cross section of the trough to become flatter and the load to spread out at the center of the span. This slope then is the ruling factor; and since the slope is proportional to the ratio of sag to span, this ratio will serve as the required criterion. In the case under discussion, this ratio is 1.39 to 3.5 or 0.394 in. sag per ft. of idler spacing. As emphasized before, this value is a maximum or rather a little more than good practice warrants. Judging from other conveyors $\frac{3}{8}$ in. per foot should be considered a maximum with $\frac{5}{16}$ in. per foot a preferable figure.

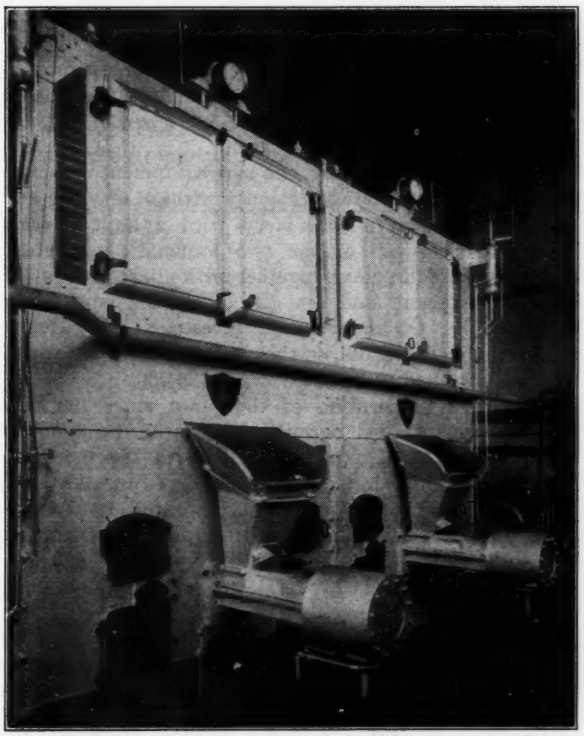
Whatever method is followed for determining the proper counterweight, a recognition of the need of belt tension for the prohibition of objectionable change in the shape of the cross section of the material at and near the loading point as it passes over the idlers will produce a better running conveyor than will the practice of ignoring the necessity. The antifriction idler increases this need as does the modern three-pulley design with 20 deg. slope. The plain bearing grease lubricated idler in use when most belt conveyor design specifications and formulas were compiled required more power and consumed a larger part of the belt weight on the slope in friction. This of course required more counterweight. In most cases, the amount of counterweight required for traction was sufficient to control the sag. Then, too, the old five-pulley idler with 30 deg. slope provided a stiffer trough than do the 20 deg. designs. As is often the case, improved equipment demands on the part of the designer a more comprehensive understanding of the problems involved. With the coming of this understanding, it is to be expected that some single drives will be used where tandem drives would otherwise have been installed, as could have been done in the case of the conveyor just described with no increase over the belt stress at which it was finally operated.

Clarinda, Iowa, will be developed into distribution center for the Iowa-Nebraska Light and Power Co. in that territory, S. T. Lee, district manager, has announced. Beginning March 1, work will start upon installation of a 1400-hp. generating unit. The plant now has a 2000-hp. unit.

Power Utilization

Economy Gained By Modern Equipment In Small Plants

By W. S. Johnston



Right—Two Stokered Boilers Give Double the Output of Three H. R. T. Replaced

ECONOMY in the generation of steam is as much the privilege of the owners of small power plants as of large central stations, no method being open to the one that is denied the other. The fundamental factors in the solution of the problem of cheaper steam are the use of equipment efficient as possible, arrangement of the equipment to minimize space requirements, efficient management in the operation of the plant and judicious purchase of raw materials and supplies required. The greatest opportunity to save real money lies in economical use of fuel through adoption of modern means for its utilization.

In one case of a steam heating plant in a business building constructed about 12 yr. ago, two horizontal return tubular boilers with hand-fired, shaking grates were installed. One boiler was operated in summer to provide the service required, while both boilers were run in winter at moderate overload. Four years later, a new office building invited a proposal from the management of the power plant for the supply of steam for heating and other purposes. A contract was signed, the power plant had to be increased in size and, by slight alterations in arrangement, another similar boiler unit was added. The new load afforded some operating economies in summer and gave better load factor in winter so that selling steam proved profitable, the rate having been wisely worked out to cover not only the operating costs but also the fixed charges on the additional equipment and a reasonable margin of profit.

Two years later, another new building was erected next door and the management duly signed up on a contract for heating steam. Two duplicates of the original units, were purchased, which carried the load successfully from an operating standpoint and profitably for the owners.

Thus was developed a small compact central heating system, with short runs of mains and a large portion of steam sold returned as heating drips, so that cost of make-up water was minimized. The owners, though, became unpleasantly aware that they could conquer no new worlds, as there was no more space in the basement for new boilers.

As it stood, the plant had five 125-hp. tubular boilers operating at a summer load factor of 30 per cent and during the winter at 80 per cent. Three boilers were operated in summer at about normal rating, while all five developed 150 per cent of rating or better during the winter months. One attendant acted as pump man and water tender all year round. Two firemen and one ash handler sufficed during the summer but four and three, respectively, were needed the balance of the year. The night shift employed one man in summer and two in winter.

Annual cost was as follows: Fuel, $17,600; labor, $5680; water, $550; supplies and miscellaneous, $500; maintenance, $1500; total operating cost, $25,830; fixed charges, $14,500; general expense, $10,000; total annual production cost $50,330. The gross revenue was $57,700 per year.

Down the street, in the same block, it was proposed to build a large hotel whose promoters asked to purchase the hotel steam from the plant. This meant a 40 per cent increase in output and was a tempting piece of business. On consultation, engineers gave assurance

that the space occupied by the present plant could be made more productive and its net revenue increased.

The engineers proposed to remove the original three tubular boilers that summer, while the load was light and, in their place, install two water-tube boilers with automatic stokers to develop twice as much steam in winter as the three old ones and with efficiency under winter load conditions 7 per cent higher. One of the new boilers would carry the entire summer load, including that for the hotel, at 15 per cent increase in efficiency. The operating personnel could be cut down all year round by one fireman, while one less coal and ash handler would be needed in winter.

Besides the two boilers, the new equipment consisted of additional coal storage capacity with an elevator and receiving hopper; a coal larry with a built-in scale served the hoppers of the two automatic underfeed stokers. New equipment, together with alterations in the building basement and removal of the old equipment, cost $66,900. Of the original investment of $97,000, there remained $72,100, so that investment, upon which fixed charges had to be based, was $139,000.

One year's operation of the plant since the new boilers were installed permits analysis of the financial results obtained. Production costs with the increased load of the hotel for the year ending June 30, 1931 were: Fuel, $22,385; labor, $5225; water, $775; supplies and miscellaneous, $1510; maintenance, $2105; total operating cost, $32,000. Fixed charges, $20,850; general expense, $10,000; total annual production cost, $62,850.

Because of lower unit production costs with the more efficient boilers, the contract price of steam to the three business buildings was reduced 5 per cent and the gross revenue of the power plant for the year was $75,700.

Comparison of the revenue and production costs for the last two years gives:

	Year ending June 30		Increase
	1930	1931	%
Gross revenue	$57,700	$75,700	31
Production costs, including fixed charges	50,330	62,850	24
Net income	7,370	12,850	75
Operating ratio, per cent.	87	83	

Tonnage of coal used last year increased about 27 per cent over the previous year and it is anticipated that for the coming year a more advantageous contract will be written. If so, the management proposes that the benefit shall be passed to the customers in the form of decreased rates for the ensuing year.

As to future growth, when opportunity to take additional load occurs, the management plans to replace the last two tubular boilers with an automatically-stoked water-tube boiler, to be rated at 400 hp. and with furnace designed to permit operation at 300 per cent of rating, thus giving one unit that will develop as much steam as the two 250-hp. stoker-fired boilers can now generate, or over three times the capacity of the two tubular boilers. Present coal and ash handling equipment has sufficient capacity to serve the new boiler unit but another boiler feed pump will have to be bought and larger steam piping will be needed to accommodate the increased plant output.

Initial installation and the first extension of tubular boiler units was justified but the last battery of two such boilers was not the wisest choice. It would have been cheaper in the long run to have purchased one water-tube boiler of less rated capacity, capable of carrying greater overload and operating at better efficiency. Production costs would have been decreased by fixed charges on a smaller investment by lower fuel bills through more efficient use of that consumed and probably by a decrease in operating labor. The management is now working along the right lines with respect to the future and can expect to realize the maximum profit from the plant's operation.

Steam Accumulator for Paper Mill Service

Two Years' Operation Confirms Expected Advantages. By N. H. Sandberg*

IN CONJUNCTION WITH high-pressure power plants the steam accumulator has many advantages but conditions must be taken into consideration when working out the heat balance of the plant in order to make the accumulator a profitable investment. The original heat balance worked out for the Waldorf Paper Products Co. high-pressure power plant is shown, based on an hourly average requirement for 225 t. daily production. It was felt that conditions as shown could be maintained and a steam accumulator with a capacity of 12,000 cu. ft. was purchased and installed. All steam passing through the d.c. unit was delivered to the accumulator at 75 lb. gage while the steam used for generation of a.c. current was exhausted directly into the process steam header at 40 lb. gage.

To get the full benefit from the accumulator, it was essential that the steam required for power production be always less than the average process steam demand and a sufficient pressure differential must exist between the turbine exhaust and the process steam to allow the accumulator pressure to vary between these two pressures. This would give storage or steam releasing capacity to the accumulator and under such conditions maintain a proper balance between the process steam and the electric energy required. Process steam demand must exceed the exhaust steam supply from the turbines so that at all times there was need for make-up steam direct from the boiler for process work. This additional amount of steam was passed through the reducing valves marked P.R.V. to the accumulator where it was desuperheated and mixed with the exhaust steam from the d.c. turbine. For this purpose, cold raw water was introduced into the accumulator.

During short shut-downs on the paper machine for felt changes or drier breaks, when the electric load greatly exceeded the steam load, the surplus steam from the turbines was stored in the accumulator. No high-pressure steam from the boiler was admitted to the accumulator at these times and, if this condition extended over one-half hour, it was usually possible to readjust the electric load before the storage capacity of the accumulator became overtaxed. When the paper machine was started again, increase in demand for process steam was rapid, this sudden demand being met

*Mill Superintendent, Waldorf Paper Products Co., St. Paul, Minn.
Presented before a Meeting of the T.A.P.P.I.

**See Power Plant Engineering, July 1, 1930, p. 734, for a complete description of this plant.

from steam release in the accumulator by allowing the pressure to drop back into normal range.

If properly installed and heat balance similar to the one outlined in the illustration be maintained, the steam accumulator will undoubtedly perform the following functions:

Reduction of Installed Boiler Capacity

With the accumulator, it would be possible to even out the peaks in the steam demand on the boiler, allowing a reduction in boiler capacity and improving the over-all efficiency of the boiler by permitting practically constant firing. A master pressure gage should be located in the boiler room and the firing should be regulated so as to keep the accumulator pressure within a certain range. With accumulator pressure dropping below a certain point, the firing should be increased and the boiler pressure raised above 640 lb. At this point the overflow valve automatically would open to admit live steam to the accumulator. On the other hand, when the accumulator pressure worked up near the high range, the firing should be decreased and the boiler pressure allowed to drop below 640 lb. so that the overflow valve would close. This makes it possible to maintain practically a constant boiler pressure. When the load on the turbines is suddenly decreased, no steam is wasted by the safety valves popping as, when the pressure reaches 640 lb., steam passes into the accumulator through the overflow valve until firing can be reduced.

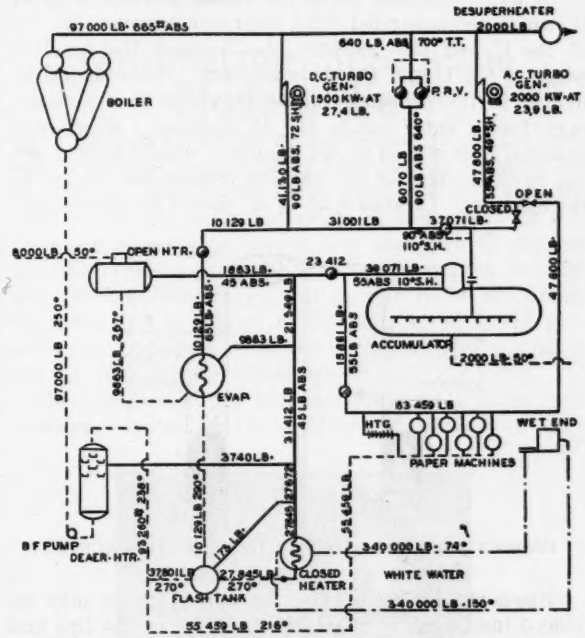
Stabilization of Process Steam Pressure

One of the most important functions of the accumulator in the board mill was stabilization of pressure and desuperheating of the makeup steam. If exhaust pressure on the turbines of 75 lb. gage and process steam pressure of 40 lb. gage were maintained, it was possible to allow the accumulator pressure to vary within the close limits of these two pressures, yet maintain constant pressure of the process steam, thus insuring maximum drying capacity as well as uniform drying and improved quality on the paper machines.

Elimination of Stand-By Power

This feature of the accumulator action would apply only to a plant with no auxiliary power service for starting up in case of a forced shutdown. The Waldorf Paper Products Co.'s boiler room was entirely motorized with the exception of one boiler feed pump so that, in case of a shutdown on the a.c. turbine, all boiler room apparatus would go down and, without some outside source of power, it would be impossible to start the boiler again. With the accumulator at an average pressure and the use of a low-pressure turbine to drive one boiler feed pump and one pulverizer, it was possible to operate with steam from the accumulator a sufficient length of time to get the a.c. turbine back on the line again, so that it was possible for the company to eliminate a stand-by service contract, resulting in a considerable saving. The last mentioned feature of the accumulator was most important during the winter months when steam was required for heating the plant as, in event of a forced shutdown of the boiler, the accumulator would supply heating steam for several hours or until the spare boiler unit could be put into service.

Heat balance as shown was arrived at from the average requirements for 1928, additional capacity for future expansion provided for in the new plant being based on the 1928 ratio between steam and power required per ton of paper. Additional tonnage taken on with the completion of the plant was mostly high grade and light weight boards requiring much more power for stock preparation, while little additional exhaust steam was needed. The situation was further changed by an increase in power demand from other departments which have no use for process steam except for heating in the cold season. The electric load then exceeded the steam load and the proper pressure differential of the turbine



HEAT BALANCE OF THE WALDORF PAPER CO. 650-LB. PLANT

exhaust and the process steam could no longer be maintained without exhausting to the atmosphere. In order to reduce the volume of the exhaust steam, it was necessary to drop the back pressure of the d.c. unit to 55 lb. with the process steam at 40 lb. gage. This practically eliminated the steam storage feature of the accumulator but it was left in service to maintain constant process steam pressure.

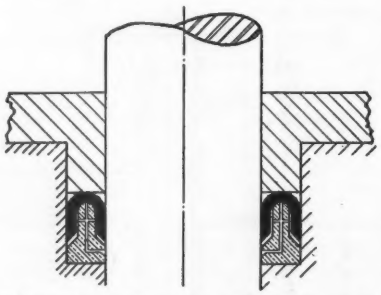
It was further necessary to equip one of the boiler feed pumps with a low-pressure condensing turbine, replacing the 300-hp. induction motor originally installed, to take steam at the throttle at 40 lb. gage and, with a vacuum of 28 in., having a water rate of about 35 lb. By this installation the boiler room auxiliary load was reduced over 200-kw., which made it possible to generate an additional 300-kw. on the a.c. unit as the steam required for that amount can be condensed through the low-pressure turbine. In other words, it increased the generating capacity 500 kw. over the original arrangement.

When the production in the mill cannot be scheduled to balance the power plant, which usually occurs when light weight paper is made on both paper machines, the power plant avails itself of the low-pressure condensing unit, which has so far been of sufficient capacity to balance the power and steam requirements.

Letter U Packing Pointers

RATHER than curved, the end of the gland bearing on the shoulder of the U packing should be square is the statement in the New Houghton Line, as the shoulder of the packing will become square after a few applications of pressure and the packing form a better seal against the plunger or rod. If the gland nose is concave or clearance between rod and gland is excessive, use of a safety pad washer of leather under the gland is suggested, $\frac{1}{16}$ in. thick, outside diameter the same as that of the packing, inside diameter that of the plunger or rod.

Where conditions permit, a bronze pedestal ring as shown is recommended with clearance between the lip of the U and the pedestal, also between the bevelled edges of the U and the pedestal base. Holes should be drilled in the pedestal ring as shown so that pressure may freely enter inside the U packing. Whether a pedestal ring is used or not the gland should never force the beveled edges of the packing against the bottom of the chamber. Clearance of $\frac{1}{8}$ in. should be maintained.



PROPER INSTALLATION OF LEATHER U PACKING

Supporting ring of fiber or canvas tucks may be placed inside the U to extend $\frac{1}{8}$ in. below the lips and be notched at the bottom to permit pressure to equalize on both sides of it.

High grade leather should be used, impregnated with a filler which is insoluble in the liquid used around the plunger. Longer life will more than repay any extra cost.

Embrittlement of Wire Rope

ONE PROBLEM which has received considerable attention in oil fields where the gas contains a high percentage of hydrogen sulphide has been the embrittlement of steel rope, particularly cable tool drilling lines. Atomic or nascent hydrogen rapidly causes embrittlement in steel, resulting in failures with a characteristic jagged appearance without necking, as contrasted to the relatively smooth break of unembrittled, fatigued wire or the smooth diagonal appearance of worn or abraded failures. If allowed to remain in the air for a day or more, the embrittled rope recovers a portion of its original ductility, similar to the behavior of wire pickled in acid solutions, commonly termed acid or hydrogen brittleness.

Molecular hydrogen cannot produce brittleness in steel but hydrogen sulphide combining with the iron in the rope causes nascent hydrogen to be occluded, which results in extreme brittleness. The tensile strength is practically unaffected and the hardness is slightly increased, indicating that the effect is largely a surface reaction. Study of the crystalline character of the failure justifies the opinion, according to a paper presented before the A.S.M.E. by Leslie W. Vollmer and Blaine B. Westcott, that the atomic hydrogen is absorbed by the intercrystalline material to form molecular hydrogen with a change in volume which produces severe boundary strains within the metal.

Speed with which this embrittlement takes place was determined for 0.688 per cent carbon steel. Embrittlement increased steadily from 20.4 per cent in 15 min. to a maximum of 69.8 per cent in 3 hr. Samples of wire allowed to stand in the open air for 24 hr. showed a decrease in the original degree of embrittlement from 70.0 per cent to 12.8 per cent. At the end of 7 days, embrittlement had dropped to 6.4 per cent, representing the recovery of 90.9 per cent of the ductility loss. Similar results can be effected in shorter time by heating. Systematic periods of rest or periodically baking for 3 hr. will, therefore, materially increase the life of uncoated steel drilling lines in sulphide fields, or of other rope exposed to the action of nascent hydrogen.

Tests of the effectiveness of various coatings showed that tin affords practically no protection. A thin zinc coating gave partial protection for three days. Ordinarily, galvanized zinc coating and lead gave protection for the total time of the test, that is 120 hr., while copper gave complete protection, the wire actually gaining with rest to its initial rotary endurance strength. Galvanized rope can be used to advantage in these conditions but is unsuited to ordinary use because of its lower strength and resistance to abrasion.

Refrigeration in the Dairy Industry

By T. L. Kimball,* Chief Machinist, Bowman Dairy Co., Chicago, Ill.

IN THE FIELD of cooling fluid dairy products the application of modern development in mechanical refrigeration has been somewhat neglected and the opportunities in this field are practically unlimited for the application of modern methods of economy in operation of mechanical refrigeration equipment. Fluid dairy products are of two classes: fluid in the natural state and concentrates of high viscosity. Types of coolers fall in three general classes; internal tube, surface and vat and coil system, the cooling mediums in general use being brine solutions, ice or chilled water and direct expansion.

In selecting cooling equipment, careful consideration should be given to both the viscosity of the product to be cooled and cooling medium employed. The flow of high viscosity products through internal tube coolers of the large diameter tubes is not turbulent, so the heat transfer is very slow. In this type of cooler, the internal tubes should be of the smallest practical diameter and of sufficient surface to obtain the desired results with the cooling medium at a temperature that will prevent the freezing of the product in the tubes. The surface type of cooler is best adapted to this class of cooling and good results have been obtained with 20 deg. F. cooling mediums using concurrent flow through the

*From a paper read before the N.A.P.R.E.

lower section of the surface cooler. The concurrent flow eliminates the danger of freezing the product to the lower tubes.

In the cooling of dairy products, it has been the general practice to use calcium chloride brine as a cooling medium. Unless the brine solution is properly treated the corrosive effect on some metals of which milk cooling equipment is constructed is well known. The chemical treatments of brine are more or less individual in each case as the operating temperatures affect the corrosive action on the different metals. In coming in contact with a large number of dairy plants using brine as a cooling medium, it was found that one of the principal causes of corrosion in cooling and circulating equipment was due to air being mixed with brine at some point. This should be carefully guarded against and eliminated if possible.

Corrosive effect of brine has been greatly checked and in some plants entirely eliminated by having a chemical analysis made by a competent chemist familiar with the subject and using the chemical treatment recommended. In making up a new brine, it is important to have a chemical analysis made and later tests will show any changes in composition and the causes can be more easily determined and the proper treatment applied.

In the development of the multi-suction compressors, multi-feed coils, float control, temperature and pressure control valves a new era is at hand for higher operating efficiency in the dairy cooling industry. In a recent large installation for the cooling of dairy products and making ice, first consideration given to the refrigeration equipment required was to obtain the highest possible operating efficiency, with the desired flexibility and as near as possible a compressor load balance between the high and low suction pressures available. Equipment best adapted for results desired was chilled water as cooling medium and multi-suction compressors operating on three suction pressures. For flexibility and to maintain the highest possible operating efficiency, it is of advantage to have two or three smaller, rather than one large unit, with split suctions and multi-suction bypassed to end suctions of compressors. With this arrangement, it is possible to maintain a balanced load between the different suction pressures throughout the entire operating period.

There are several advantages in using water for cooling medium in milk equipment; cheapest in first cost and replacement; no corrosion of equipment; less liable to damage goods being cooled; where steam sterilization is used, the equipment can be drained before sterilizing, saving steam and time required.

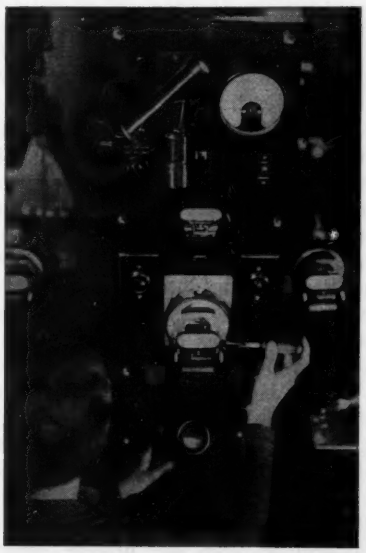
Cooling surfaces of milk equipment should be sufficient to give the desired temperature with water temperature of not less than 34 deg. F. At this temperature with water cooling equipment, multi-feed or flooded type ammonia coils equipped with pressure control or float valves the operating suction pressure can be maintained at about 45 lb. This pressure operating either on simple suction or multi-suction in combination with lower suction pressures from an ice field or other equipment is a factor of economy in operation.

There is no doubt that the greatest economy of operation can be obtained from the use of the direct expansion milk coolers. Surface type direct expansion coolers have been in use for a number of years and have proved satisfactory. One fact that must be borne in mind with all types of expansion coolers is that the full refrigeration load starts the instant the cooler is started so the compressor must be of sufficient capacity to carry the load. There is no reserve to draw from as in brine or water cooling system. In operation this type of cooler has shown good capacity per square foot of surface if properly equipped with automatic controls to prevent freezing in operation or a sudden shutdown. If the cooler is of the flooded type, provision should be made to remove the ammonia when high heat is applied for washing or sterilizing.

Calibrating Meters the Modern Way

STROBOSCOPES are simple mechanical devices used to compare speeds. They have been in common use in physical laboratories for a great many years. By their means not only can speeds be compared but motions can be made to appear slow and even to stop. A rotating airplane propeller observed through a rotating disk, having holes in it, will appear to be stationary when the disk is rotated at the same speed as the propeller, or appear to turn over slowly when the disk is rotated at a slightly slower speed.

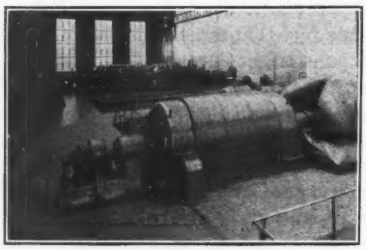
In this picture, the girl is calibrating a house type electricity meter by the stroboscopic method—a very



good example of an ancient idea put to a modern use. A sharp beam of light shines through openings in the rotating disk of the upper or "standard meter," which is known to be 100 per cent correct. This interrupted light beam falls upon the disk of the meter being calibrated. It takes a girl only a few minutes to calibrate a new meter by this means because she merely moves an adjusting screw until the disk appears to stop.

The viewing opening near the girl's left hand is arranged to magnify the marks on the edge of the tested meter disk and is located to give the maximum convenience and repose, therefore the least fatigue to the operator.

POWER PLANT ENGINEERING February 1 1932



PARALLEL OPERATION OF A. C. GENERATORS

By E. H. STIVENDER

Part III.* Conditions determining the value of the coupling angle. Relation of correct phase angle to generator and bus voltages. Current and power conditions present while pulling out of step. Conditions determining correct grounding of neutrals. Connection of transformers. . . . . .

IT IS NOTICEABLE that as a generator supplying a nonreactive load is made to take on more load the power factor lags more, if the excitation is not changed. As will be explained later, since the power factor meter measures the cosine of the angle between the system voltage and the current flowing, its indication does not necessarily show the relation between each generator's internal voltage and the current flowing.

As an illustration of this, a section of the Blondel diagram is shown in Fig. 1, Angles AOC and OAC′ are equal and have a value whose tangent is $\frac{X}{R}$ where X is the synchronous reactance and R is the resistance of the generator. Since R is seldom more than 5 per cent of X, these angles will be practically 90 deg.

E_1 represents the bus voltage while E_2 is the generator voltage. The voltage vectors are given in topographic form for simplicity. The center of the power arcs P_2 and P_{12} is at the intersection of OC and AC′, hence since angle AOC is nearly 90 deg., these arcs will approximate straight lines parallel to E_1.

In this discussion, it must be remembered that the voltage E_2 cannot be directly measured while the generator is connected to the bus, nor can the angle between E_1 and E_2 always be measured with instruments provided on the switchboard. Power factor meters and voltmeters will measure values pertaining to E_1, and where the power system is of large generating capacity and interconnecting lines are of low impedance, E_1 remains practically constant during variations of E_2. Of course the smaller the power system to which the generator is connected, or the greater the impedance of the interconnecting lines between the generator and large generating stations of the system, the greater will be the variations of E_1 during variations of E_2.

Since tan AOC is X/R and the current I lags behind $OE_2 = E_R$ (the resultant voltage of E_1 and E_2) by an angle whose tangent is X/R then the power factor is either the cosine of angle BOD or the cosine of the angle between $-E_1$ and I. In this diagram it is in some cases more simple to use cos BOD as the power factor.

The length of E_2 is proportional to the field excitation, since a.c. generators nearly always operate below the bend of the field saturation curve. When E_2 swings above OA, motor action takes place (since I is then to the right and E_2 to the left of the Y axis). When E_2 swings below OA, as is shown in Fig. 1, both I and E_2 are pointing to the left of the Y axis and E_1 and I are in opposing directions, indicating load being supplied to the bus. OA is the zero load axis or where P = zero.

As a load P_2 is being carried by the generator, E_2 terminates on arc P_2 at point B. Now if E_2 is decreased the power output will remain unchanged but E_2 moves along arc P_2 to a point B′, the coupling angle OAB′ is now greater than its former value OAB, and the power factor, cos DOB has changed to cos DOB′, representing a greater value of E_R, hence a greater current I′ and a lower power factor.

Consider E_2 to remain constant while the load is increased to P_{12}, where E_2'' intersects with B″. The coupling angle has increased to OAB″, the phase angle has become B″ OD and the current has become I″. In order to maintain the original power factor, the excitation must be raised until E_2 becomes the value E_2''', where B‴ is in line with line B-O and the angle B‴ OD equals BOD.

Here we see the condition mentioned earlier in this article. The power factor meter measures the cosine of the phase angle between $-E_1$ and I, where the current

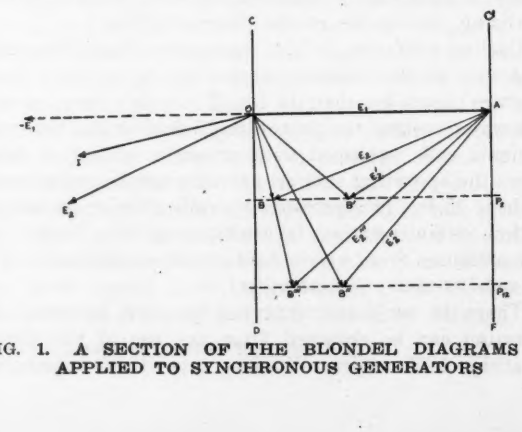


FIG. 1. A SECTION OF THE BLONDEL DIAGRAMS AS APPLIED TO SYNCHRONOUS GENERATORS

*Parts I and II appeared in the October 15 and December 1, 1931 issues on pages 1023 and 1147 respectively.

leads, but when E_2 is drawn in crank form with its origin at O, it is observed that the current I lags behind the generator voltage E_2 by the angle IOE_2. This means that the reactance of the generator causes the voltage to drop as load is increased.

Due to the relatively small value of resistance and iron losses, the actual power lost (I^2R) in a generator carrying load is very small unless the rated load is being carried at a power factor much lower than was intended in the design of the machine, for since the power lost increases as the square of the current a small increase over rated current, due to low power factor, may cause consumption of several times the power lost in heating at rated power factor.

Importance of maintaining a small coupling angle is manifested by inspection of Fig. 1. When vector E_2 swings past line C'F, the rotor poles are more than 90 deg. past the stator poles, and the machine pulls out of step.

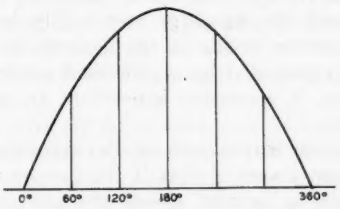


FIG. 2. THE CURRENT VALUES PRESENT DURING SLIP OF TWO COMPLETE POLE PITCHES OR 360° OF COUPLING ANGLE

When the load is suddenly increased, due to a heavy overload, if more field current is not supplied, E_2 will swing in a clockwise direction in an effort to reach power circles farther out. As 90 deg. is approached the lag of the current increases so that less power is required from the prime mover to increase the coupling angle, due to weakening of the field flux by the heavy lagging currents. The governor does not prevent pulling out of step.

In order to prevent pulling out of step, the field current must be raised a sufficient amount to neutralize the action of the increasing coupling angle. Here we see the importance of high speed automatic voltage regulators where generators must be kept in parallel operation during abnormal conditions. Since, due to mechanical inertia, the governor cannot act quickly enough to prevent a sudden burst of speed, voltage regulators must be depended upon to prevent the coupling angle from reaching 90 deg.

It is not the practice in modern power stations to provide overload protective relays for generators, hence if a generator pulls out during abnormal conditions, an additional overload is imposed upon the system due to the change in e.m.f. value of the generator. Figure 2 illustrates in graphic form the value of the current flowing in a generator with constant field excitation during a complete counter-clockwise revolution of E_2. At the left of the diagram E_2 is parallel and equal to E_1, where the current and power are zero. As E_2 moves downward and toward the right the current rises until E_2 is 180 deg., or in the same direction as E_1, hence the resultant E_R is twice E_1 and the maximum current (ignoring the effect of saturation) is $\frac{2E_1}{X}$. Between 180 deg. and 360 deg. the current decreases to zero.

In many cases, where there is noticeable line reactance between the runaway generator and other synchronous machines as is usually the case, E_1 will decrease, hence the current will not reach as high a value as otherwise.

Where the current rises to sufficient magnitude to cause saturation in the magnetic circuit the curve will be more peaked at 180 deg., since then the reactance X of the generator has very little effect and the current limit is determined only by the resistance R of the machine and the impedance of the line. Another interesting effect of saturation is that the current no longer lags 90 deg. behind line voltage, since practically no reactance is present; hence since the counter voltage of the line reactance is at 90 deg. to the IR drop of the generator windings, less combined limiting effect is offered to the flow of this large current.

The power curve of Fig. 3 is significant of the behavior of a generator after the coupling angle has

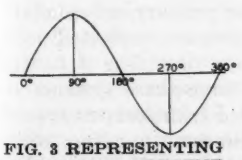


FIG. 3 REPRESENTING THE POWER PRESENT IN A GENERATOR CIRCUIT DURING A CHANGE IN COUPLING ANGLE OF 360°. THE PART ABOVE THE LINE REPRESENTS GENERATOR ACTION; THAT BELOW, MOTOR-ACTION

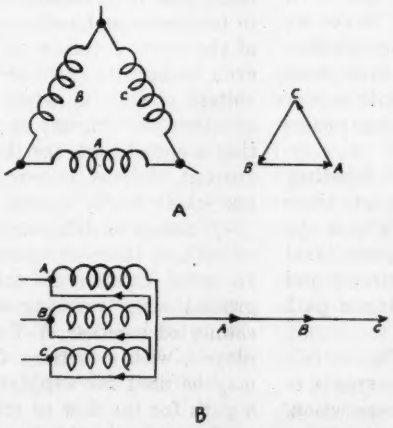


FIG. 4. A. SHOWING THE DISTRIBUTION OF THE WINDINGS OF A THREE PHASE DELTA CONNECTED MACHINE WITH RESPECT TO THE PHASE VOLTAGES. B. SHOWING THE DISTRIBUTION WITH RESPECT TO THIRD HARMONIC VOLTAGES

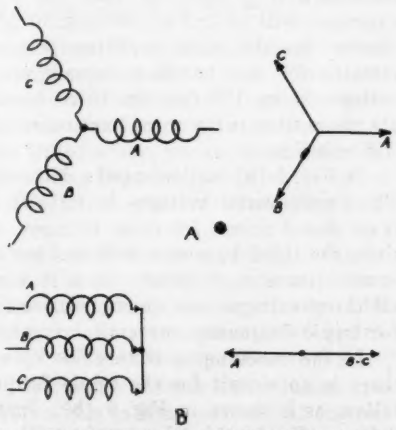


FIG. 5. A. DISTRIBUTION OF THE WINDINGS OF A THREE PHASE Y-CONNECTED MACHINE WITH RESPECT TO THE PHASE VOLTAGES. B. DISTRIBUTION WITH RESPECT TO THIRD HARMONIC VOLTAGES

reached 90 deg. At the 90-deg. point the power output is maximum; beyond this as the angle increases the power decreases, hence the machine is unstable and tends to increase in speed since it is governed no longer by the load. At 180 deg. the power is again zero and as the coupling angle moves toward the 270-deg. point the power is negative, representing motor action and the machine tends to increase in speed until the 360-deg. point is reached, where a further increase in the angle tends to increase the power output of the machine and decrease its speed. Of course, in most cases before E_2 makes one half revolution the generator has been cleared of the line by circuit breaker operation at some other point in the system. The foregoing is given as an illustration of the importance of keeping the generator in step, since due to the accelerating action of the power flowing, after the 90-deg. point is passed it is difficult for generators to re-synchronize. For this reason, much expense is often undergone to provide high speed automatic voltage regulators.

Grounding the Neutral

When generators are operated in parallel, it is often the case that the neutral of only one machine may be grounded, otherwise the flow of currents of higher frequencies will be experienced. If the generators are identical in construction, the neutrals may all be grounded without any objectionable results, but it is often the case that when new machines are operated in parallel with older ones rather heavy currents of triple frequency will result.

The most prominent of the higher harmonics is the third, being caused mainly by the varying character of the reluctance of the magnetic circuit due to coil slots in the core. Magnetic hysteresis is also sometimes largely responsible for the presence of triple frequency voltages in generators. Since the impedance offered to this current in generators is relatively low, if the circuit of higher harmonic currents is closed, the results may show fairly large currents which will increase heating of the windings and produce interference in neighboring telephone lines by magnetic induction.

Owing to the frequency of the third harmonic being triple that of the fundamental wave, if one cycle of the fundamental is 360 deg. then one cycle of the third harmonic will be 1/3 of 360 deg. or 120 deg., hence we observe the desirable condition present in three-phase circuits, for, due to the angular spacing of three-phase voltages being 120 deg. the third harmonic will be single phase, that is the third harmonics of the three phases will coincide.

In Fig. 4 (a) is illustrated a delta connected winding. The fundamental voltages being 120 deg. apart, there is no closed circuit for these voltages; but in Fig. 4 (b) since the third harmonic voltages are single phase, that is zero phase angle exists, there is a closed circuit and all three voltages are short-circuited, providing a path for triple frequency currents.

If the machine is connected Y, as in Fig. 5 (a), there is no circuit for the triple frequency currents to follow, as is shown in Fig. 5 (b). In either connection, delta or Y, the third harmonic voltage will not appear in the line leads, since in the former case all the voltage is consumed in the windings and in the latter its effect between lines is neutralized, as inspection of Fig. 5(b) will show. The only cases where the triple harmonic of three phase generators can appear in the load circuit is where a three phase-four wire system is used, where improper grounding of neutrals is done, or where a generator is connected open-delta.

If Y connected generators producing third harmonic voltages which are not in synchronism when the fundamental waves are in synchronism are paralleled on a common bus with their neutrals grounded, then a closed circuit is formed through the bus and ground. For this reason it not infrequently occurs that objectionable results are encountered when such a parallel connection is made. Likewise it is often unsatisfactory to connect a grounded neutral generator to a transformer whose primary neutral is grounded. Generator neutrals may be safely grounded when the machines are paralleled on the secondary sides of transformers.

With modern distributed and fractional pitch windings, higher harmonics of voltage can practically be eliminated, for instance in a 2/3 pitch winding, where the coil sides are 120 deg. apart, the third harmonic is eliminated and the windings may safely be connected in delta; however, owing to the desirability of a fixed neutral, as is provided by a grounded neutral point at the generator, Y connected generators are used almost altogether.

Higher Harmonics of Transformers

It has been observed that if the proper precautions are not taken to prevent closed circuits, objectionable disturbances may result due to the presence of the generator third harmonic of voltage, that is the prominent higher harmonic present in generators is that of voltage, since generator harmonics are greatly due to uneven flux distribution. The triple frequency voltage still appears from line to neutral in a Y connected generator but does not appear between the lines. In the case of transformers operating high on saturation curve (as do many transformers) the prominent harmonic is the third harmonic of current. Owing to magnetic hysteresis and saturation, the wave form of the magnetizing current must be distorted in order to maintain a sine wave of voltage. If this third harmonic of current is suppressed in transformers by the use of Y-Y connected windings, distorted voltage waves will exist which may lead to destructive high frequency voltages on the transmission lines, due to resonance; also objectionable interference to telephone and radio communication. Since distortion of the wave of voltage between lines must be eliminated, even though its existence from line to neutral on lower voltage circuits is rarely objectionable, delta connection of either the primary or secondary is used, thus permitting a closed path for the flow of the third harmonic of current, thereby consuming any triple frequency voltage which might appear.

It makes no difference whether primary or secondary, or both, in three-phase transformers are connected delta. In some installations, such as for providing a neutral ground when two ungrounded three-phase systems are connected together, Y-Y connected transformers are employed, with a tertiary delta connected winding, which may be used for supplying a load as well as providing a path for the flow of triple frequency currents.

It is usually the case, however, that the higher voltage side is connected Y in order to provide a grounded neutral, hence decrease the insulation required for the transmission line; also opportunity is given for a basis for protective relay settings.

Care and Operation of Power Transformers

Part II.* Instructions for placing units in service, care of oil, inspection, removing scale from cooling coils, operation, importance of temperature as an indicator of transformer condition. An abstract of a booklet issued by the National Electrical Manufacturers Association. . . . . .

BEFORE A TRANSFORMER is filled with oil, all accessories, such as valves, gages, thermometers, plugs, etc., must be fitted to the transformer and made oil-tight. The threads should be filled in accordance with instructions from the manufacturer before putting them in place.

In filling with oil, metal hose must be used instead of rubber hose because oil dissolves the sulphur present in rubber and may cause trouble by the sulphur attacking the copper. After filling, the oil should be allowed to settle at least 12 hr. and then samples taken from the bottom should be tested again before voltage is applied to the transformer.

It is very important that the surfaces of the oil when cold (25 deg. C.) be at the oil level indicated by the mark on the oil gage. When the transformer is not in service, the oil level must never be allowed to fall to a point where it does not show in the gage.

When the voltage is first applied to the transformer, it should, if possible, be brought up slowly to its full value so that any wrong connection or other trouble may be discovered before damage results. After full voltage has been applied successfully, the transformer should preferably be operated in that way for a short period without load. It should be kept under observation during this time and also during the first few hours that it delivers load. After four or five days' service it is advisable to test the oil again for moisture.

Water Circulation

If the transformer is water-cooled, the main water valve should be opened as soon as the oil temperature reaches 45 deg. C. If there are two or more sets of cooling coils in parallel, the valves of all sections should be adjusted for equal rates of flow. This can be estimated by feeling the weight of the discharge streams from the different sections. It can be determined best, however, by noting the difference in temperature between ingoing and outgoing water from each section. A careful measure should be taken of the total amount of water flowing through all sections and the total rate of flow adjusted to a value not less than that specified.

Care

The idea that a transformer in service needs no attention may lead to serious results. Careful inspection is essential and the directions given in this section should be followed. In spite of all precautions, moisture may be absorbed by the transformer if it is of the open type and during the first few days of operation it is well to inspect the inside of the manhole cover for moisture. If sufficient moisture has condensed to drop from the cover, the transformer should be taken out of service and dried. The oil should be tested and dried if necessary.

Closed type transformers should have their oil tested at top and bottom after the first few days of operation to make sure that no moisture is being given off from the transformer into the oil.

Samples of oil from all transformers should be drawn and tested at least once every 6 months. During the first month of service of transformers having a potential of 40,000 v. or over, samples of oil should be drawn each week from the bottom of the tank and tested. If at any time the oil should test below 16,500 v., it should be filtered.

Inspection

Closed type transformers when properly dried out and installed will need thorough inspection only infrequently, that is, only when there are specific indications of trouble. Other types of transformers should be taken out of service periodically for a thorough inspection. The inside of the cover and the tank above the oil should be regularly inspected to see that they are clean, dry and free from moisture and that the thermometer bulb is clean. If an appreciable amount of dirt or sediment is found inside the case, it is best to take out the transformer and remove the oil from the tank. The transformer and the tank should then be cleaned thoroughly and the oil filtered and tested. In cleaning, only dry cloths or waste should be used. If the transformer is water-cooled, the cooling coils should be cleansed thoroughly.

In the case of water-cooled transformers, the rate of flow should be checked from time to time and if it is found to have diminished, the cause should be looked for and remedied. The most frequent cause of clogging of cooling coils is the presence of air in the water, resulting in the formation of a scaly oxide.

Removing Scale from Cooling Coils

Scale and sediment can be removed from a cooling coil without removing the coil from the tank. Both inlet and outlet pipes should be disconnected from the water system and temporarily piped to a point a number of feet away from the transformer, where the coil can be filled and emptied safely. Especial care must be taken to prevent any acid, dirt or water from getting into the transformer.

All the water should be blown or syphoned from the cooling coils which should then be filled with a solution of hydrochloric (muriatic) acid, specific gravity 1.10. (Equal parts of commercially pure concentrated hydrochloric acid and water will give this specific gravity.)

It may be found necessary to force this solution into the cooling coils. When this is done, one end of the coil should be partially restricted so that the solution will not be wasted when the coil is full. After the solution has been in the coil about an hour, the coil should be flushed out thoroughly with clean water. If all the scale is not removed the first time, the operation should be

*This is the second of two articles published under this title. The first appeared in the November 1, 1931, issue.

repeated until the coil is clean, using new solution each time. The number of times it is necessary to repeat the process will depend on the condition of the coil though ordinarily one or two fillings will be sufficient.

As the chemical action which takes place may be very violent and may often force acid, sediment, etc., from both ends of the coil, it is well, therefore, to leave both ends partially open to prevent abnormal pressure.

Idle Cooling Coils

When a water-cooled transformer is idle and exposed to freezing temperatures, the water must be blown out of the cooling coil. In addition to blowing out the water, the cooling coils should be dried by forcing heated air through them. If not convenient to do this, the coil should be filled with transformer oil.

Operation

An artificially cooled transformer should not be run continuously, even at no-load, without the cooling medium. Therefore, it is essential to maintain a proper circulation in the cooling system.

If the water circulation is stopped for any reason, the load should be immediately reduced as much as possible and close watch kept of the temperature of the transformer. When the oil at the top of the tank reaches 80 deg. C., the transformer must be cut out of service at once. This temperature should be recognized as an absolute limit and must not be exceeded. It should be held only during an emergency period of short duration.

Temperature

Thermometers should be read daily or more often. If the indicated oil temperature is 80 deg. C. or over for a self-cooled unit or 65 deg. C. or over for a water-cooled unit, the transformer must be cut out of service at once and the cause of the excessive heating investigated.

Regardless of oil temperature as indicated by thermometers, the transformer must not be operated at overloads not stipulated by the specifications or contract. When the contract specifies an overload, a water-cooled transformer operated at such an overload should have the amount of water increased in proportion to the load. On account of the increased amount of water during overload, the temperature of the windings and any of the causes leading to excessive heating will have more pronounced effect under these conditions; therefore, the transformer during overload should be watched with especial care to see that the oil temperature is kept well below the temperature limits specified.

Moisture may get into an open type transformer, due to the fact that as oil is heated and cooled it expands and contracts, therefore air is expelled from and enters the transformer. If the air which enters the transformer is at the same time cooled off by contact with the cover to below its dew point, moisture will condense.

It is therefore good practice to operate transformers at several degrees above air temperatures at all times. This will largely prevent condensation.

Sampling and Testing of Oil

The sample container should be a large mouth glass bottle. All bottles should be cleaned and dried with gasoline before being used. A cork stopper should be used.

The sample for dielectric tests should be at least 16 oz. and, if other tests are to be made, 1 quart (32 oz.).

Test samples should be taken only after the oil has settled for some time, varying from 8 hr. for a barrel to several days for a large transformer. Cold oil is much slower in settling and may hardly settle at all. Oil samples from the transformer should be taken from the oil sampling valve at the bottom of the tank. Oil samples from a barrel should be taken from the bottom of the drum. A brass or glass "thief" can be conveniently used for this purpose. The same method should be used for cleaning the "thief" as is used for cleaning the container.

When drawing samples of oil from the bottom of the transformer or large tank, sufficient oil must first be drawn off to make sure that the sample will be comprised of oil from the bottom of the container, and not from the oil stored in the sampling pipe. A glass receptacle is desirable so that if water is present, it may be readily observed. If water is found, an investigation of the cause should be made and a remedy applied. If water is not present in sufficient quantity to settle out, the oil may still contain considerable moisture in a suspended state. It should, therefore, be tested for dielectric strength.

Testing

For testing oil, for dielectric strength some standard device for oil testing should be used. The standard oil testing spark gap has disc terminals 1 in. in diameter spaced 0.1 in. apart. The testing cup should be cleaned thoroughly to remove any particles of cotton fibre and rinsed out with a portion of the oil to be tested.

The spark gap receptacle should be filled with oil, both oil and spark gap being at room temperature or approximately 25 deg. C. After filling the receptacle allow one-half to one minute for air bubbles to escape before applying voltage.

Rate of increase in voltage should be about 3000 v. per second. Five breakdowns should be made on each filling and then the receptacle emptied and refilled with fresh oil from the original sample. The average voltage of 15 tests (five tests on each of three fillings) is usually taken as the dielectric strength of the oil. It is recommended that the test be continued until the mean of the averages of at least three fillings is consistent.

Dielectric strength of oil when shipped is at least 22 kv. tested in the standard gap. If the dielectric strength of the oil in a transformer in service, tests at less than 16,500 v., it should be filtered. New oil of less than the standard dielectric strength should not be put into a transformer.

Solder, recently discovered by the Allied Research Laboratories of Glendale, California, is called Alumaweld, and is claimed to repair any metal, including cast iron, steel, aluminum, pot metal, die castings, brass and bronze. The broken part is cleaned, then heated with an ordinary soldering iron, then the solder, with special flux, is applied and the repair completed. Average pipe repairs, made without tearing down the system, take from 10 to 12 min. Use has been made for repair of steam and water pipes, crank cases and cylinder heads on automobiles, aluminum pots and pans, vacuum cleaners and washing machines. Alumaweld is stated to withstand hydrostatic pressure up to 1000 lb., and will hold steam up to 500 lb. at live steam temperature.

Welded Steel Plate Condensers Have Advantages

LIGHT WEIGHT, REDUCED AIR LEAKAGE AND LOWER COSTS RESPONSIBLE FOR RAPID ACCEPTANCE OF NEW DESIGNS. BY HAROLD M. GRAHAM*

EXPERIENCE in the fabrication of welded steel plate condensers covering the past three years has demonstrated the advantages of this type of construction over the conventional cast iron shell design. The main advantages are lower first cost; stronger construction; lighter weights; elimination of spring supports; lower field costs for erection; better design; elimination of many gasketed joints; possibility of making exhaust connection and shell in one piece, practically eliminating

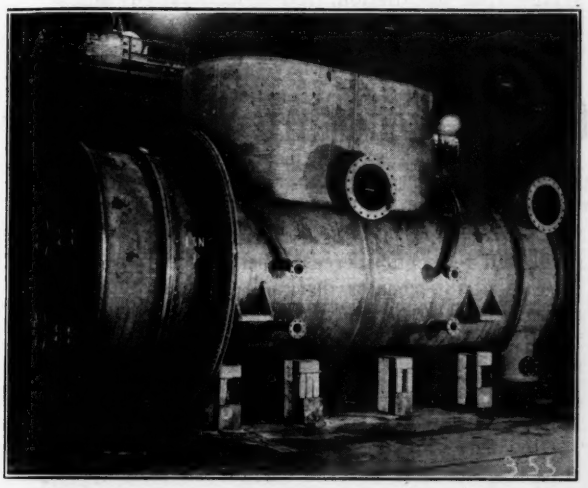


FIG. 1. A 11,500-SQ. FT. CONDENSER FOR A 10,000-KW. TURBINE. TUBES ARE ROLLED AT BOTH ENDS, THE EXPANSION JOINT IN THE SHELL IS AT THE LEFT OF THE EXHAUST CONNECTION

air leakage in the shell itself; ease of making necessary repairs and greater flexibility of design.

Strength of the welded steel plate condenser and its mechanical flexibility is a wonderful help. Large, bulky cast iron shells are, structurally, perhaps the weakest piece of machinery installed in power plants. Handling of these large, bulky, parts of the condenser shell requires extreme care as breakage is disastrous because parts of these large cast-iron condenser shells are machined in the shop to fit and if one is broken in the field, the replacement part of the shell is never an exact duplicate of the one broken.

Ability of the welded steel shell easily to take care of expansion strains due to temperature changes gives the welded steel plate shell a decided superiority. A study of some of the recent condensers turned out shows innovations in design that are desirable but practically impossible with cast iron construction.

Figure 1 shows one of two 11,500-sq. ft., two-pass surface condensers that have been in service some six months, giving excellent results. A study of the picture will show some of the desirable features of an electrically welded shell which consists of one completely fabricated unit with no bolted or gasketed joints. The exhaust connection piece is integral with the shell, a feature that would be impossible with cast iron construction. The expansion joint in the shell just at the left of the exhaust connection permits the tubes to be rolled at both tube sheets.

Advantages of this particular installation may be listed as follows: Shell in one piece eliminating joints and possibility of leakage of these joints; much lighter construction permitting the elimination of all spring supports for the condenser, complete condenser being hung from the turbine exhaust flange; strength and flexibility of the steel plate shell permits tubes to be installed at both ends and difference in expansion between the brass tubes and the steel shell to be taken up in the expansion joint shown.

LEAKAGE ELIMINATED

This construction gives a condenser in which the possibility of raw water leakage into the condensate is

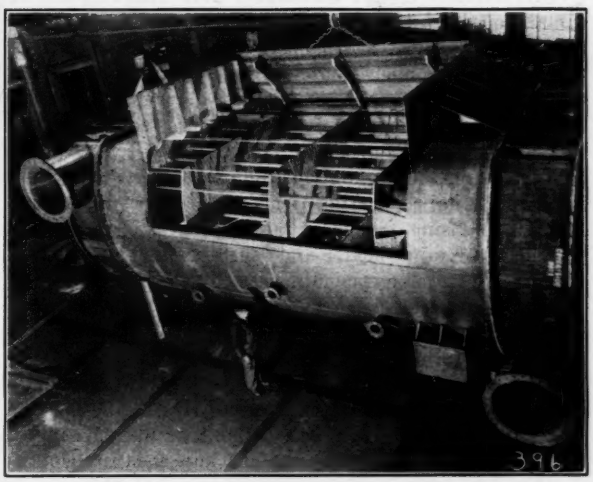


FIG. 2. A 29,000-SQ. FT. CONDENSER UNDER CONSTRUCTION FOR A 35,000-KW. CENTRAL STATION TURBINE

eliminated and the possibility of air leakage through the shell flanges is reduced to the minimum. Elimination of spring supports gives a better layout with more room in the basement.

Taking advantage of the flexibility of design permitted in a welded steel plate condenser, many of the details are simplified and result in a much cleaner cut design and more graceful condenser lines as shown by Fig. 2, a 35,000-kw. steel plate condenser under construction. The ribbing of the flat parts of the condenser shell is simplified and gives a dependable design. Support plates welded directly to the sides of the condenser shell give strong and sure construction.

The one illustrated is the first condenser of this size in which the shell is made in two pieces split longitudinally. The longitudinal split is welded in the field.

*Ross Heater & Mfg. Co., Buffalo, N. Y.

This permits the exhaust steam inlet flange to be completely machined in one operation, resulting in a much better surface and giving a much truer flange. The horizontal split is doweled in the shop and welded in the field, the split being necessary because railroad shipping facilities make it necessary to ship this shell in pieces.

Experience in building welded steel plate condensers during the past years has convinced us that this construction will entirely supersede cast iron construction in the near future but experience and care are necessary in building them. Experience has resulted in a reduction in the amount of welding necessary particularly field welding. Field welding is naturally more expensive as facilities available in the field are much more limited than those provided in a good shop. We have tried to limit field welding to the simplest details so that no distortion will result. Experience has also made it possible to eliminate the possibilities of distortion due to welding and permit building to a much closer tolerance than was previously possible with steel plate construction. We are able to turn out units with much closer tolerances than is thought possible with cast iron shells.

In the smaller sizes, it is possible to fabricate the condenser shell, exhaust connection, hot well, and air offtake connections in one piece. Advantages of the steel plate construction have also been extended to the air ejector part of the condenser where the same advantages apply and elimination of a number of gasketed joints made possible.

We believe that the use of welding can be carried further in the installation of condenser equipment and that in a short time air leakage through flange joints will be practically eliminated. It is also believed that the air and water piping, on both types of condenser installations, can be welded in the field to give more symmetrical installation, tighter installations and better installation at a lower cost.

Radiant Superheater Developments

A Summary of Experience with Radiant Superheaters Since 1923 Showing the Work that Has Been Done in This Field and Pointing Out the Advantages of This Equipment. By M. K. Drewry*

SUSTAINED HIGH STEAM TEMPERATURES at all operating ratings, not peak readings at one narrow load range, are being sought in the industry's quest for higher operating efficiencies. Uniform average temperatures, not maximum values, determine commercial economy and even safety of higher steam temperatures. Since premiums are paid for high-temperature equipment on the basis of maximum temperatures, it is important that operating temperatures be uniformly high. Decreasing trends of boiler duty and increasing tendencies of super-heater and reheater duty, plus multivalving of turbines, emphasize the inadequacy of purely convection surfaces for maintaining uniform temperatures. A 200-deg. F. drop in reheated-steam temperature from full load to quarter load when using only convection surfaces was diminished to 20-deg. F. decrease in the planning of a recent large 1200-lb., 850 deg. F., single-turbine, single-boiler installation, simply by prescribing two-thirds radiant superheating equipment.

Since 1923, 20 boiler units at the Lakeside Station have been equipped with various types of radiant superheaters as the art advanced and thoroughly satisfactory installations were developed. Original installations employing the special heavy forged-steel elements proved that massiveness of element structure was unnecessary, and in fact undesirable, for 300-lb. steam-pressure service. Figure 1 contrasts their heavy cross-section with the simple light-weight elements later found so desirable.

That the new elements effectively absorbed heat throughout their periphery was proved immediately by the fact that only 60 per cent as many were required to get full steam temperature. Reflection from the brick-work backing wall not only helped maintenance of the elements by maintaining uniform metal temperatures front and rear, but increased heat-absorption efficiency. In radiant-superheater design it is desirable whenever steam scrubs a surface and thus causes pressure drop, that useful heat absorption occur at that point. The superseded elements were not efficient from this standpoint, for only one face was heated and connecting nipples caused much of the pressure loss.

Obviously, metal temperature, not steam temperature, is the vital determinant of radiant-superheater maintenance. Consideration of the reliability of high steam temperatures too often omits study of the temperature difference between heated steam and heating metal.

At the time when the first round tube elements were installed, little information on the heat transfer rate from metal tubes to superheated steam was readily available. To supply the want, metal temperatures were measured and heat transfer rates to a water-cooled tube nearby, plus furnace temperatures, were observed as shown in Fig. 2.

Because of agreement of measured and calculated metal temperatures, it is quite safe to assume that the round superheater elements operate at a temperature not in excess of 950 deg. F. It is possible that this temperature may be exceeded sometimes when starting but the fact that the observed creep was found influenced by steam-flow turbulence, Fig. 3, shows quite positively that most creep occurs during operation with metal temperatures not exceeding 950 deg. F.

Creep

It was realized early that the new type elements would probably be subject to creep, even though their operating temperature was not over 950 deg. F. and the tensile stress due to 300-lb. steam pressure was only 1200 lb. per sq. in. Accordingly, circumference measurements were taken early and frequently and data shown in the illustration, Figs. 4 and 5, were obtained.

*Asst. Chief Engineer of Power Plants, The Milwaukee Electric Ry. & Light Co. From a paper presented before the A.S.M.E. at Hartford, Conn., June, 1931. This paper received the A.S.M.E. Junior award for 1931.

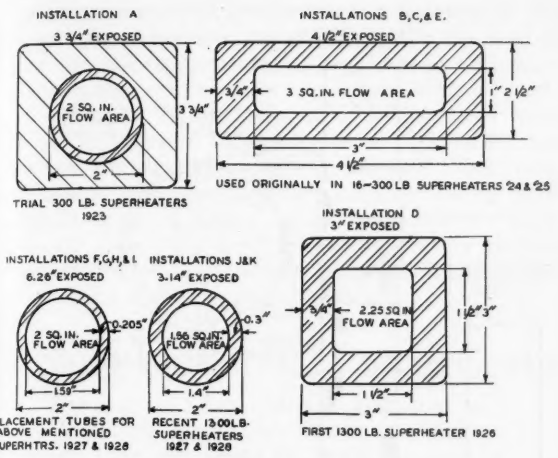


FIG. 1. DEVELOPMENTS SHOWN BY CROSS-SECTIONS
The simple round-tube sections are greatly superior to the special, heavy elements. The thinnest tube section, lower left, absorbs 20 per cent more heat than the second heavy element, upper right, though it weighs only 10 per cent as much. Its flow area is one-third less, causing desirably higher steam velocities and effective surface exposed to the cooling steam is about 50 per cent more. Most important of all, enormous and destructive temperature stresses were reduced to almost negligible items by the new design. The square 1300-lb. section, lower right, is successful but the round section, lower middle, used in subsequent installations is less expensive.

Experience with all installations indicates almost 10 per cent decrease of heat transfer the first few days of operation that is never regained. Further temperature loss due to ash accumulations is readily recovered by permanently located soot blowers. The initial surface condition of the unused black elements has apparently a higher radiant heat absorption coefficient than the slightly roughened brown tubes after service. The Enduro A tubes have been observed to retain their original smoothness longer than the carbon-steel elements and to require less cleaning of ash.

The projecting tube elements installed in the 300-lb. boiler units have the sole minor demerit of necessitating ash removal from the brick backing wall. The 10-in. space fills slowly with fragile "whisker" ash, which requires removal weekly or twice monthly. Because the high-pressure boilers are operated continuously for months without outage and because this type of hand cleaning would not be convenient, the flush-with-wall installation was used in the later equipment.

The vertical round-tube superheater, using 2-in. tubes on 2½-in. centers and backed with insulating tile, retains its original cleanliness as well as a fin-tube furnace wall. Low-grade coal of 2050 deg. F. fusion-temperature ash and 4 per cent sulphur has been burned over long periods with scarcely any soot blowing necessary. Ash particles do not collect on the brick backing, being cooled sufficiently between the tubes to fall downward as dry dust. Radiant-superheater soot-blower steam averages 1/40 of 1 per cent of the high-pressure boiler output.

Heat-transfer rates in excess of 60,000 B.t.u. per sq. ft. per hr. have not been averaged in practice. Metal temperatures and temperature stresses increase with higher heat-transfer rates and a practical limit exists, probably in the region of 75,000 B.t.u. per sq. ft. per hr., depending upon the particular conditions.

Experience with furnace types is needed to prescribe proper radiant-superheater area. Modification of area is not simply accomplished as with convection sur-

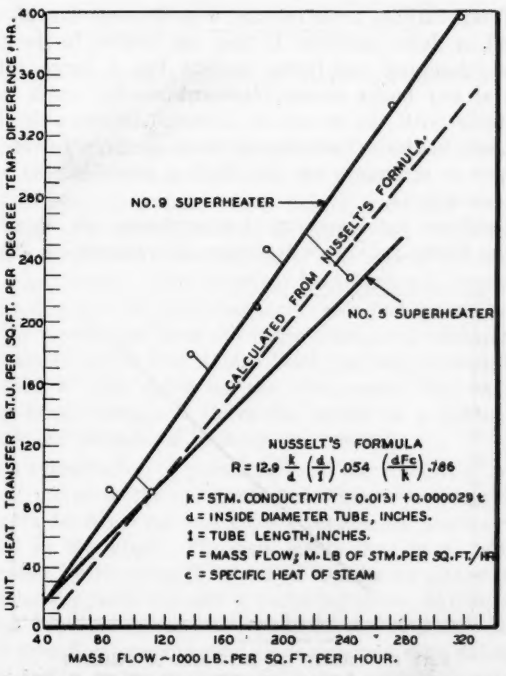


FIG. 2. HEAT-TRANSFER INSIDE SUPERHEATER TUBES
Metal-temperature measurement by thermocouples peened into elements in operation allowed calculation of the above unit heat-transfer data. Since fair agreement with Nusselt's expression was obtained, maximum operating metal temperatures were concluded not over 950 deg. F.

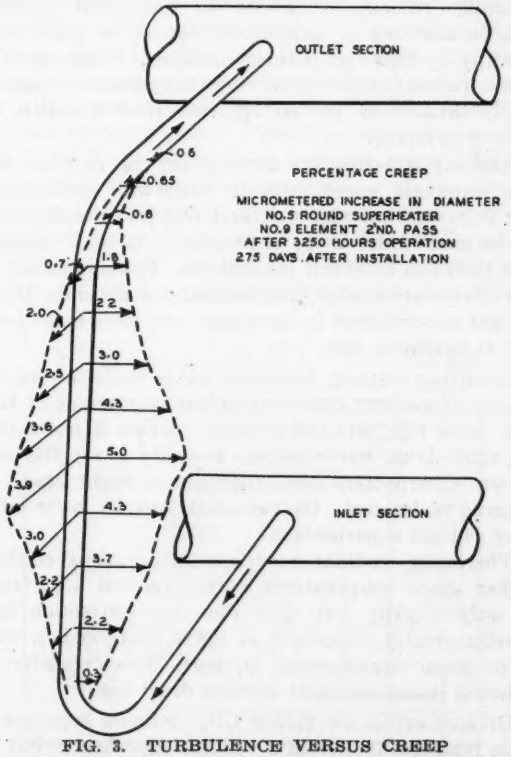


FIG. 3. TURBULENCE VERSUS CREEP
That expansion was not due to overheating when starting but occurred very slowly during operation, is the most important deduction from the above isometric sketch. Turbulence at the bends maintained lower metal-temperature than in the middle, and creep values, shown graphed in direction of diameter measured, were correspondingly lower. Higher pressure drop and greater turbulence cause better cooling and less creep.

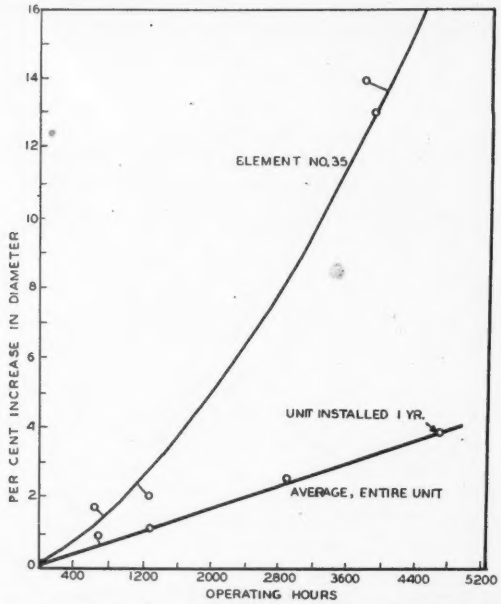


FIG. 4. CREEP RATES OF EXPERIMENTAL INSTALLATION

That creep is a linear function of operating hours is the most important conclusion from the lower curve. When expansion is so large that the tube walls thin greatly and diameter enlarges appreciably, thus increasing metal-temperature and unit stress due to pressure by several times, the creep curve probably bends upward, as shown by the upper curve. Half of the elements have been removed at convenient times before failure, and half are still in service after 3½ years. They now average 7.4 per cent creep.

faces. If of the combination radiant and convection type, adjustments can be made in the convection section. If simply radiant, brickwork or water-wall surfaces must be modified if adjustment cannot be made conveniently by flame position or dirtiness. When starting a new radiant installation, low temperatures can be readily insured by partial application of a plastic refractory covering.

Radiant superheaters located on the furnace side walls eliminate many difficult water-wall connections. It is believed that rear-wall and front-wall connections can be made much more conveniently in most installations than can side-wall connections. Fewer outside, inactive tubes are needed, and connections are more direct. Radiant superheaters in the wide walls solve these problems at minimum cost.

Crediting costs of displaced water walls toward the expense of radiant superheaters has an element of fairness. As a rule, additional boiler surface is not expensive after drum water storage capacity is set and convection superheaters have thus but a slight credit in reducing boiler cost. Overall costs may be lower when using radiant superheaters.

Thermally, radiant superheaters are most efficient. Higher steam temperatures reduce radiant heat transfer only slightly but they diminish convection heat transfer greatly, especially at lower loads and in cases where much superheating is done. Heat transfer by radiation is accomplished without draft loss.

Greater excess air (lower CO_2) reduces superheated steam temperatures from a radiant superheater but increases them from a convection heater. Exigencies of operation sometimes require an increase of excess air. It increases the safety of an installation to have the radiant characteristics apply.

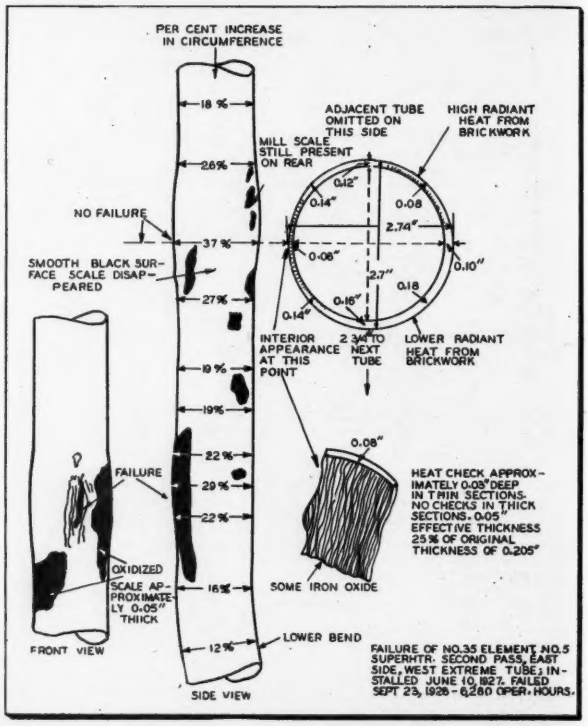

PER CENT INCREASE IN CIRCUMFERENCE
ADJACENT TUBE OMITTED ON THIS SIDE
HIGH RADIANT HEAT FROM BRICKWORK
MILL SCALE STILL PRESENT ON REAR
NO FAILURE
SMOOTH BLACK SURFACE SCALE DISAPPEARED
INTERIOR APPEARANCE AT THIS POINT
2.34" TO NEXT TUBE
LOWER RADIANT HEAT FROM BRICKWORK
FAILURE
OXIDIZED SCALE APPROXIMATELY 0.05" THICK
HEAT CHECK APPROXIMATELY 0.03" DEEP IN THIN SECTIONS. NO CHECKS IN THICK SECTIONS. 0.05" EFFECTIVE THICKNESS 25% OF ORIGINAL THICKNESS OF 0.205"
SOME IRON OXIDE
FRONT VIEW
SIDE VIEW
LOWER BEND
FAILURE OF NO.35 ELEMENT NO.5 SUPERHTR. SECOND PASS, EAST SIDE, WEST EXTREME TUBE; INSTALLED JUNE 10, 1927. FAILED SEPT 25, 1928 - 6,280 OPER. HOURS.

FIG. 5. CREEP FAILURE

A 37 per cent increase in circumference without failure occurred near the top of the tube, even though expansion around the periphery was not uniform. The original 2-in. tube section could readily be passed through the section shown. Since the effective thickness was only one-fourth of the original and the inside diameter 60 per cent more, pressure stresses were 6.4 times original stresses. Metal temperature was undoubtedly higher, because of lesser steam velocity; however, temperature stresses were greatly reduced, and the thin tube continued to bear its load. Temperature stresses appear very important and thin tubes desirable.

Temperatures from radiant superheaters can be adjusted by flame position. If they are located in the side walls, changing end-feeder speeds has a large influence at any boiler rating. Radiant-transfer rates vary inversely with the square of distance between the hot and cold bodies. Changing primary-air pressure on all burners or secondary-air distribution, modifies rear wall heat absorption.

Uniform turbine-casing temperatures are obtained by the rising radiant-superheater characteristics. Even

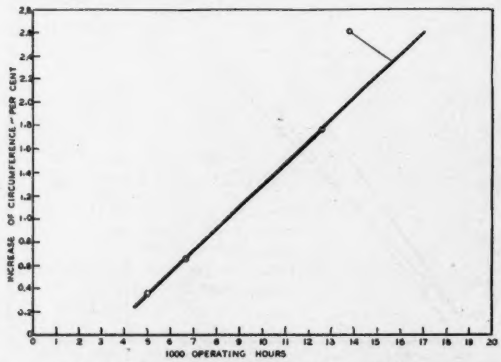


FIG. 6. CREEP OF ENDURO A TUBING

Four sets of circumference measurements of all 40 Enduro A elements in No. 3 boiler plot against operating hours as shown above. Load factor the last thousand hours has been low and unreported starting hours high, which possibly explains why the last point is above the curve. Several scattering Enduro elements showed 1.5 per cent creep, while occasionally others with 5 per cent maximums caused the recent average of 2.6 per cent.

a flat temperature characteristic is less desirable in this respect. Use of overload valves exaggerates the need of higher throttle temperatures at low loads so that more uniform casing temperatures may occur. High temperatures are safest at low loads, since heat-transfer rates through superheater tubes are less and therefore the important temperature stresses are reduced. Metal temperatures of radiant superheaters decrease slightly with rating in spite of higher steam temperatures. High excess air (low CO_2) need not be used at low ratings to maintain desirable superheat temperatures as in the case of many convection superheaters.

Cutting Industrial Power Costs

DETAILS OF LOAD CONTROL DESIGNED TO CORRELATE PURCHASED POWER AND HEATING LOAD DEMANDS. BY F. O. WALLENE*

ADVANTAGES of generating high-pressure steam and expanding it in a prime mover before using in industrial process or heating are many. They were discussed in detail in an article appearing under the above title on page 1056, Nov. 1, 1931 issue of Power

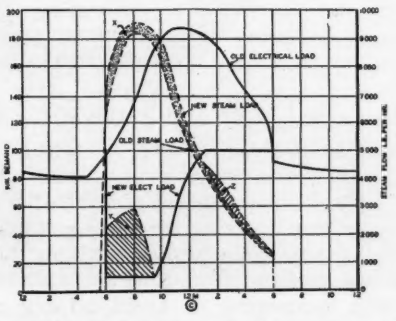


FIG. 1. ELECTRICAL AND STEAM LOADS WITH AND WITHOUT LOAD CONTROL

Plant Engineering, with particular reference to the plant of the Sanitary Milk Co. at Canton, O.

Electrical and steam loads before installing a load regulator are shown in Fig. 1, using the designation "old." Loads after installation of the control are designated as "new." The electrical load begins to increase at about 4:30 a. m. and reaches a peak just before noon but the steam load does not begin until 5:30 reaching a peak about 2½ or 3 hr. later. With the load control was installed a dual drive on the compressor, the engine being large enough to drive the motor as a generator during the periods of high steam demand.

This generation of power reduced the amount of purchased power to the curve marked "new electric load," the area between the two curves represents power generated in the plant. The new steam load is of course increased by the area X. Area Y represents steam that must be supplied through a reducing valve during the period that the steam load exceeds the electrical load while area Z represents conditions reversed with exhaust steam going to atmosphere. The load control is set to carry a minimum of 10 and a maximum of 100 kw. on the purchased power line.

*Wallene Eng. Co., Cleveland, O.

Schematic layout of the load control relay is shown by Fig. 2 to illustrate its operation more easily. Element A is a bourdon pressure tube which is connected to the process steam line. An increasing pressure causes arm C carrying contacts 1 and 3 to rotate to the right around pivot point E, while a decreasing pressure causes a reverse movement.

Element B is a wattmeter element so connected as to obtain a proportionate movement of arm D which is also pivoted at point E and carrying contact 2 as the power from the primary source increases or decreases. An increase in power causes a movement of arm D to the right closing contacts 2 and 3, while a decrease in power causes a left-hand movement closing contacts 1 and 2.

Assume that relay is set for 100 kw. maximum with minimum demand at 10 kw. and steam pressure from 4 to 5 lb. Referring to Fig. 2, when the engine is started at 6:00 a. m. the steam load is high and the pressure low, so that element A arm is resting against stop screw F. Spring K is so adjusted that 4 lb. pressure is required to lift the arm away from stop screw H. Thus it is seen that at 6:00 a. m. contacts 2 and 3 are closed, causing contactor 5 to close, and governor motor then increases the engine power. Element B, being responsive to the flow of power from primary source, arm D starts a left-hand movement because power obtained from primary source is being reduced, opening contacts 2 and 3 and coming to rest on stop screw H.

If less than 10 kw. is drawn from primary source, then contacts 1 and 2 close as arm C was stopped by stop screw F; thus the governor motor prevents any further increase in engine power which would result in reverse flow to the primary source. As noted in Fig. 2 the steam demand at this time is greater than the engine can supply because of insufficient electrical load demand. The 4 lb. exhaust pressure recedes farther, causing a standard reducing valve to bleed in boiler steam, thus preventing the pressure from dropping below 3 lb. As the electrical load keeps on increasing, contacts 2 and 3 are intermittently closed, increasing the work done by the engine. It is to be noted that element B, acting quickly upon any change in power obtained from primary source, acts as a restoring motion opening the

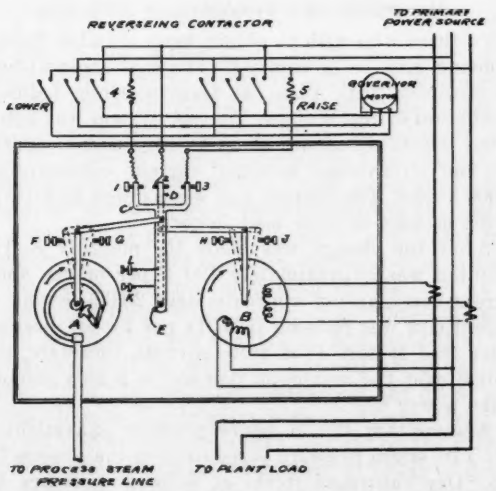


FIG. 2. SCHEMATIC LAYOUT OF LOAD CONTROL RELAY

contacts as soon as the governor is giving a satisfactory condition of operation.

At 9:30 a. m., the engine is supplying the required amount of low pressure steam, because it now has a greater electrical load to work on and also the steam demand is receding. Element A arm begins to lift from stop screw F because of the increase of pressure in the steam line. Contacts 1 and 2 are intermittently closed thus gradually reducing the engine power.

At 1:00 p. m., element A arm is resting against stop screw G. At this point, a 100-kw. flow from the primary source is sufficient to move element B arm D so as to close contacts 2 and 3, causing the engine to increase its power until 2 and 3 again open. Exhaust pressure has now increased to the point where the back pressure valve is allowing the excess pressure to escape to at-

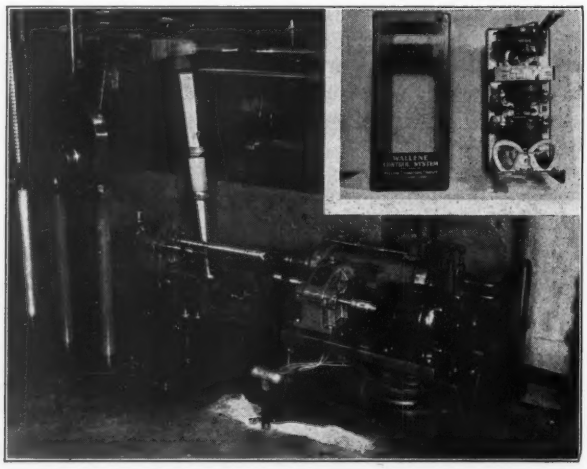


FIG. 3. LOAD CONTROL RELAY (INSERT) AND MOTOR CONTROL ON ENGINE GOVERNOR

mosphere, but with the maximum demand on the primary source limited to the desired predetermined value. Thus it is seen that the load control relay prevents maximum and minimum loads on the primary source and between these limits accomplishes a proportioning of the load depending on the demand for process or heating steam.

Practical and Theoretical Analysis

To those who wish to obtain more detailed facts, the following may be of interest. The coal consumption of the Sanitary Milk Plant at Canton, Ohio, before the installation of the Wallene Control System was approximately 180 t. per month at an average cost of $3.00 per ton, and an average monthly current consumption of 80,000 kw-hr. The current cost was as high as $.0187 per kw-hr. because of poor load factor.

After the change was made the monthly coal consumption was approximately 190 t. per month and the current consumption approximately 20,000 kw-hr. The current cost was reduced to $.014 per kw-hr., because of better load factor. It is quite obvious, therefore, that a control over the maximum demand is highly important to the power user.

Assume that 125 lb. boiler pressure is available and that 5 lb. steam pressure is required in the process steam line. Dry saturated steam at 5 lb. g. pressure has a heat content of 1156 B.t.u., while dry saturated steam at 125 lb. g. pressure has a heat content of 1192 B.t.u. or an increase of approximately 3 per cent. By the increase of 3 per cent more fuel there has been made obtainable 144 B.t.u. for adiabatic work, resulting, however, in a B.t.u. content of the exhaust steam of 1048 B.t.u.

The perfect engine would require 3415 divided by 144 or 23.7 lb. of steam per kw-hr. In practice the majority of engines will attain an efficiency from 60 to 70 per cent. Assuming 60 per cent for purposes of explanation, then the steam rate would be 23.7 divided by .60 or 39.5 lb. of steam per kw-hr. The total additional heat is less than 8 per cent, but for easy calculating, assume 10 per cent as the added fuel requirement over that required if boilers were operated at 5 lb. pressure.

Assuming coal to cost $3.00 per t. and a conservative boiler evaporation rate of 7 lb. of steam per pound of coal, then the full cost of steam per 1000 lb. is $3.00 divided by (7 × 2000) which equals 21.4 cts. For each 1000 lb. of steam there is obtainable 1000 divided by 39.5 or 25.3 kw-hr. costing 21.4 cts. equal to 0.844 cts. per kw-hr. for fuel; however, only 10 per cent of the fuel cost is chargeable to the power as the heat is already required for process purposes. Then 25.3 kw-hr. cost 2.14 cts. or a fuel cost per kw-hr. or 0.084 cts. or less than one-tenth of one cent. The initial cost of this particular installation, about $8000, was saved in less than a year.

N.E.L.A Prize Awards for 1932

Prizes to be awarded for 1932 by N.E.L.A. are announced by the committee on awards. They are as follows: H. M. Byllesby cash prizes of $250, $150 and $100 for papers on how to increase the usefulness of the accountant in the public utility industry. James E. Davidson cash prizes of $250, $150 and $100 for papers dealing with commercial or merchandising problems, consideration of coöperative selling by utilities and other dealers being recommended. Martin J. Insull cash prize of $250 for paper on public relations. James H. McGraw cash prizes of $250, $150 and $100 for papers on engineering or technical subjects. James M. Gilchrist gold medal to the company making the greatest contribution to the advancement of electrical advertising and $1000 cash prize to the individual responsible for the achievement. Augustus D. Curtis certificate to the company showing the greatest contribution to electric lighting of commercial buildings and $500 cash prize to the person or persons responsible for the achievement. B. C. Forbes public service cup to the company conducting the most constructive public relations campaign. Details of conditions for competition may be had from the Prize Awards Committee, N.E.L.A., 420 Lexington Ave., New York City. All papers and exhibits must be forwarded on or before April 1, 1932.

Acknowledgment, January 1 Issue

When compiling the list of manufacturers assisting us in the preparation of the Plant Rehabilitation Number appearing on page 56 of our January 1 issue, we regret very much that the Leeds & Northrup Co., Philadelphia, was inadvertently omitted. The company furnished us with interesting and valuable data particularly on industrial control and instruments.

Welding and Cutting Aids Plant Rehabilitation

TYPICAL EXAMPLES OF THE USE OF THE CUTTING TORCH FOR POWER PLANT WORK. BY D. R. PRATT*

AS AN AID in the maintenance, repair and rehabilitation of power plants and power plant equipment, the oxy-acetylene process of welding and cutting is firmly established. Whether the installation is small or large, the economies and advantages of this method are widely recognized. With the increasing use of welded piping in steam power plant installations, with joints as strong and enduring as the base material, maintenance costs on piping systems are being substantially reduced. Alterations, removal and replacement of old piping and equipment provide further opportunities for the use of welding and cutting, and maintenance engineers are taking full advantage of this economical and efficient means of rehabilitation.

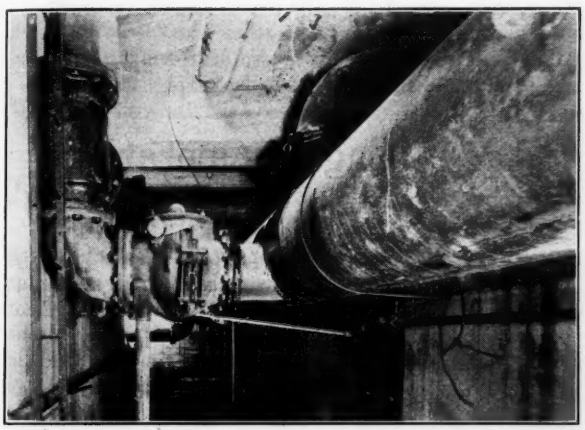


FIG. 1. A DIFFICULT PIPING JOB IN CRAMPED QUARTERS SOLVED BY CUTTING AND WELDING EQUIPMENT

PIPING

Steam stations often change piping installations in order to replace obsolete units or to expand facilities. It is in this type of maintenance that the advantages of oxwelded construction become particularly evident. An electric power plant in the southwest recently had such a problem. The plant engineer had to tear out an old 14 in. diameter low pressure turbine exhaust main and replace it with a 24 in. main in the extremely cramped quarters shown in Fig. 1. It was necessary to provide two 14-in. outlets on the 24-in. main, one at the top and one at the side connecting with a relief valve. Provision for the outlet for the latter connection was complicated by the fact that the relief valve was connected with a 14-in. line which had to pass over the 24-in. main and at the same time clear a concrete beam projecting from above. This necessitated offsetting the 14-in. outlet in the side of the 24-in. main below the center line. By using oxy-acetylene welding and cutting equipment, it was a simple matter to cut openings in the main for the outlets at the desired points, and to weld in the branch connections. The old pipe was removed with a cutting blowpipe.

*The Linde Air Products Co., New York, N. Y.

BOILERS

Obsolete boiler equipment is often given a new lease on life by the addition of a few improvements. A small midwestern power company decided to rejuvenate parts of its older boiler equipment by installing chain grate stokers. To accomplish this, it was necessary to remove rectangular sections from the cast iron boiler fronts to permit the installation of the feed chutes and grates. The removal of the 4½ by 5½-ft. section was accomplished with ease with the aid of an oxy-acetylene cutting blowpipe as shown in Fig. 2, in 4½ hr., thus reducing to a minimum the time lost by shutting down of the boiler.

Another interesting repair was recently completed on a large return tubular boiler. The difficulty in this case was in the water grate which had been eaten through by the severe corrosive action of the burning fuel. The grate consisted of two riveted steel headers, the front 8 in. and the rear 10 in. in diameter, connected by seamless drawn tubes screwed in the rear and expanded in the front header. These tubes formed the upper grate surface which was connected to the shell in such a manner as to draw a supply of cool water from the bottom of the boiler and then discharge heated water near the water line, thus promoting circulation. As the boiler manufacturer could not promise immediate shipment of new grates and headers, it was decided to fabricate a new unit by welding. The old grate was first removed from the boiler by cutting off the boiler connections close to the headers with a cutting blowpipe. The grate and headers were then laid out on the furnace room floor for accurate measurement in order to get an exact duplicate. The headers were first constructed of steel plate rolled and welded longitudinally. The ends

FIG. 2. REMOVING OLD CAST-IRON BOILER FRONTS BEFORE INSTALLING STOKERS

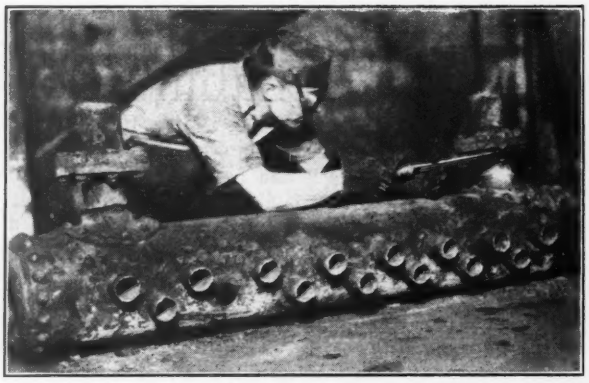


FIG. 3. PREPARING A WATER GRATE HEADER FOR REPAIRS

were then beveled and end plates welded in place. The holes in the header were next carefully cut out according to templet and the grate tubes welded in. Figure 3 shows the old header after it was removed and Fig. 4 shows the new grate in position.

Engines

Steam power plant equipment of 20 yr. ago consisted of massive slow speed reciprocating engines direct connected to generators. These units take up as much floor space as several modern turbine units of similar capacity, besides having a materially lower efficiency and higher maintenance cost than a turbine. Consequently, many reciprocating units of huge proportions are being scrapped and the removal of such masses of metal would present a difficult problem were it not for the cutting torch. It is a recognized fact that cutting with the oxy-acetylene blowpipe or oxygen lance offers the most economical method of removing such equipment.

A typical example is that of a 500-kw. engine-generator in a power plant in the middle west. The dismantling of this unit required the removal of 650 t. of metal, a substantial portion of this weight consisting of a flywheel 27 ft. in diameter. The flywheel rim, Fig. 5, was 21 by 31 in. in cross section and it was necessary to make five cuts through the cast iron rim. After cutting out the links and cutting the spokes, the rim was removed in 10 pieces, each about 8½ ft. long, weighing about 8½ t.

FIG. 4. THE REBUILT GRATE BACK IN THE BOILER

FIG. 5. REMOVING A 27-FT. FLYWHEEL WITH THE AID OF A CUTTING TORCH

After removing the flywheel hub, crank discs and other parts attached to the shaft, the 36-in. diameter steel shaft was cut in 5 ft. lengths. The ease with which a task of this magnitude is accomplished makes the oxy-acetylene process an indispensable aid.

Diesel Engine Operation

Methods of Starting Engines, Locating Leaky Valves, Selecting Fuel Oil. By W. D. Campbell

IN STARTING a Diesel engine, care should be taken not to overprime it. If the starting cylinder gets too much fuel, pre-ignition may occur, resulting in a bent connecting rod or fractured cylinder head. The engine should not be turned over too many times under air pressure. As it expands through the valve, the air may chill the engine cylinder and, if the air is allowed to do this frequently, the cylinder may become so saturated with moisture that it will not fire when the fuel is turned in.

In starting an old Diesel engine, reasonable precautions should be used. When the pistons are badly worn, the starting air blows down the pistons, making it difficult to turn the engine over fast enough to secure ignition. In cases like this, many engineers, without realizing the danger, are in the habit of giving the cylinders a shot of gasoline through the admission valves, but, if the engine is barely turning over, the gasoline will fire and there is grave danger in this precedure. The gasoline will explode early in the compression stroke and, even though cylinder heads are fitted with relief valves, they may fail to open. This has caused blowing out of admission valve cages, bending of connecting rods and fracturing of crankshafts.

One of the best ways to start a badly worn engine is to set the air starting valve open after the piston has passed dead center. Considerable air will thus be saved, because the piston will be moving outward when the air strikes it on the second turn. A good precaution to prevent too much leakage around the piston is to pour in on top of each piston about a pint of good lubricating oil. The oil will effectually seal the clearance and will raise the compression pressure high enough to ignite the fuel when the fuel valve opens. There is no danger of the lubricating oil pre-igniting. When thus handled, the engine, even though badly worn, will usually fire.

Even the methods outlined above will fail to secure results, however, in some cases where engines are badly worn. In such cases, I would advise blocking open the admission valves of the firing cylinders until a fairly high angular velocity is attained. Throwing the admission valve into place at this time will invariably bring about regular firing. Obviously the correct relief is the reboring of the cylinders and the installation of new pistons. It happens, however, that occasionally the engineer cannot induce the management to do this and if not, the above reliefs will be of benefit. Under no conditions should gasoline or kerosene be used in the above methods.

Another trouble that may confront Diesel engine operators is caused by leaky injection air valves. The main difficulty is that the engineer may be unable to determine which valve leaks. One effective method for finding out is as follows: if a valve seems to be warmer than usual, it is proof that the valve leaks, provided no valve ahead of it is hot. In this case, the last hot valve is the leaky one. For example, if the high-pressure suction and discharge valves are hot, also the intermediate discharge valve, the engineer can be certain that the intermediate valve leaks. On the other hand, if only the high-pressure valve is hot, that is the leaky one. Another method of detecting the leaky valve is by the drop in the gage pressure on the engine, if there is a pressure gage on each stage.

Under ordinary operating conditions, the fuel used should burn completely, leaving no residual matter in the cylinders such as soot, coke or ash; it should be as clean as possible to prevent clogging of pipe lines, valves and nozzles; at ordinary temperatures, it should flow to the fuel pump; it should be free from water, as water reduces the heating value of the oil, also free from highly volatile constituents that may evaporate at ordinary temperatures; above all, it should have a high heat value.

In general, fuel oils that deposit the smallest amount of residue operating at a temperature of 750 deg. F. and that have the greatest volume of vapor coming over between 390 and 750 deg. F. are better suited for use in Diesel engines.

Ash is probably the most detrimental residue of the burning of fuel oils in Diesel engines, because it wears cylinders and exhaust valves. This ash is extremely hard and is composed of mineral particles, such as quartz, silicate or oxide of iron. These small particles, becoming mixed with the film of lubricating oil, wear the piston and cylinder walls.

Hydraulic Butterfly Valves

METHODS OF SEALING, OPERATING MECHANISMS, APPLICATIONS. BY ROSS L. MAHON*

BUTTERFLY types of valves as developed in the hydraulic-power industry during recent years have such a wide field of application and find such general use in modern hydroelectric installations that information in regard to them will be of interest.

As butterfly valves of larger size came into common use and as they were employed under higher heads, the problem of properly handling the leakage became a difficult one, and those engaged in the manufacture of this equipment began to give attention to some means for reducing the clearance between the closed disk and the body.

With valves larger in diameter and heads increased, it became necessary to develop more powerful operating mechanisms. In many cases, purchasers' specifications required that these operating mechanisms be sufficiently powerful to close the valve while normal full water flow was passing through it. For some installations, it was even specified that the valve be capable of closure under full spouting velocity, such as might occur in the event of a rupture in the turbine casing or penstock below the valve and today it is usually required that the operating mechanism for a large valve shall be arranged to close it automatically whenever the water velocity exceeds a predetermined maximum.

The butterfly valve finds its application not only at the lower end of the penstock adjacent to the turbine but at the upper end of the pipe line where it emerges from the surge tank, tunnel, or forebay. Large butterfly valves, because of their low first cost and ease of operation, are being frequently used in diversion dams on large power projects to serve as head gates.

*Vice-president and general manager, The Pelton Water Wheel Co. From a paper delivered before A.S.M.E. Annual Meeting, New York, December, 1931.

DESIGN OF BUTTERFLY VALVES

The disk of one of these valves must be designed for heavy bending moments because, when it is closed against full penstock pressure, it will act as a rigid beam supported at its central point. The necessary strength is obtained by introducing heavy ribbing into the disk casting. In the modern valve, these ribs are placed within the disk, which, of course, is hollow with its outer surfaces as smooth as possible to present the least resistance to water flow. A characteristic streamline cross-section is found in almost all of the larger modern valves.

Bearings, which are located in the valve body and which carry the main valve shaft, are of conservative design, with large areas to transmit properly the enormous forces from the disk to the body structure without causing excessive bearing pressures. Renewable bronze bushings are usually fitted to the bearings and means are provided for ample lubrication, usually grease, forced into the bearings under high pressures.

Probably the most common method of insuring a practically watertight joint between the closed disk and the body of a butterfly valve is the use of metal seal rings. These are usually made of bronze or some similar non-ferrous metal and can be attached either to the body or the disk, or to both. Their design involves a means for adjusting the seal-ring position on the body or disk in order to make it match accurately the surface against which it seats, as shown in sketch.

Operating Mechanism

For the smaller-sized butterfly valves, operating under low and medium pressures, a mechanical operating stand consisting of gearing (spur, worm, or bevel type) is well suited. Such a mechanism is ordinarily actuated by means of an electric motor arranged for push-button control from some convenient point adjacent to the valve.

There is a definite limit, however, to the amount of power that can be generated by this type of operating gear without involving the use of excessively large and cumbersome machinery. This limit is often exceeded

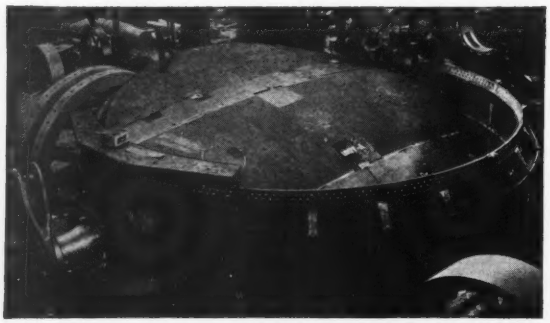


FIG. 1. BUTTERFLY VALVE 27 FT. IN DIAMETER FOR 89-FT. HEAD

with some of the equipment in use today and for the larger butterfly valves, as well as those that operate under high heads, some form of hydraulic operating mechanism can be employed to advantage.

Where the penstock pressure is relatively high, a hydraulic cylinder receiving pressure water directly from the pipe line provides an effective means for operating the butterfly-valve disk.

As penstock valves are not ordinarily required to remain in other than the full-closed or full-open positions, there is usually no necessity for having the mechanism self-locking at intermediate points. If this self-locking feature is desired, however, a simple restoring mechanism may be added to the operating cylinder that will hold the valve disk in any mid-position desired. A mechanical safety lock is sometimes provided at each end of the piston stroke so that the disk may be securely held in either the closed or the open position.

For the operation of large butterfly-valve disks under low penstock pressures, an operating cylinder using water from the pipe line becomes excessively large and unwieldy. In such a case it is customary to use an operating cylinder of comparatively small dimensions, supplied with high-pressure oil from an accumulator or pressure tank, charged by a pump driven by an electric motor.

In an interesting new type of hydraulic mechanism that has been used on large butterfly valves built within the past few months, the hydraulic cylinder utilizes oil at about 1500 lb. pressure, supplied to it by a special high-speed multi-cylinder reversible displacement pump, mounted directly on top of the cylinder itself and direct-connected to an electric motor. No pressure tank or accumulator is needed, as the pump is connected directly to the cylinder and simply transfers oil from one side of the piston to the other. Instead of the usual limit switches, special flow motors are used at each end of the piston stroke to break the electric-motor circuit automatically and to bring the mechanism to rest.

Automatic Features and Bypasses

When a butterfly valve is located at the upper end of penstock serving a modern hydroelectric plant, it is often required that it be so arranged as to close automatically should the velocity of the water column exceed normal, as, for example, in the case of a rupture in the pipe line below the valve.

One device that has been thoroughly effective in accomplishing this automatic closure consists of two pilot tubes inserted within the penstock, adjacent to the butterfly valve, and connected by means of brass or copper tubing to special diaphragm type of control valve that is extremely sensitive to pressure changes. The control valve can actuate the operating mechanism of the butterfly valve.

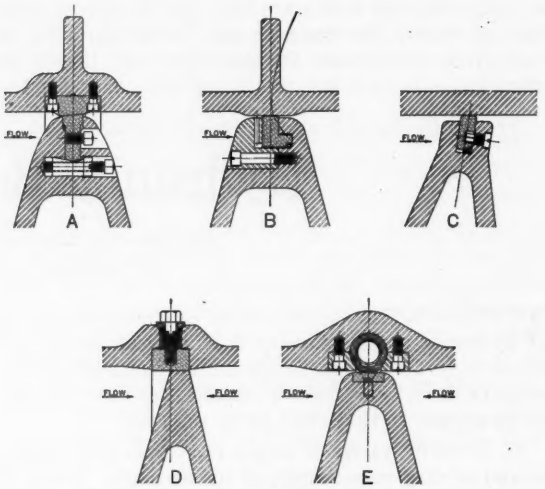


FIG. 2. TYPES OF ADJUSTABLE SEAL RINGS

Another device often used consists of a vane or paddle located within the penstock and adjacent to the valve and mounted on a lever that carries an adjustable balancing weight at its outer end. The weight can be set to make the vane sensitive to any desired water velocity within the penstock and, by a suitable tripping device will cause the operating mechanism on the butterfly valve to close its disk when excess velocity occurs.

Another safety device that has been applied to many valves now in actual service makes it impossible to open the main valve until the pressure on both sides of the closed disk has been equalized.

Bypass valves are of many types, depending on the conditions under which they are installed; they may be connected directly to openings provided in butterfly-valve bodies or placed in piping that connects to the penstock above and below the butterfly-valve body.

For many of the sizable dams constructed during recent years it has been necessary to provide for the discharge of comparatively large quantities of water that must be bypassed at certain seasons of the year to supply the needs of power plants, irrigationists and owners of riparian rights located below the dams.

When the total water quantity that must be discharged through a dam is no more than can be passed through a single valve, the Larner-Johnson regulator fulfills all requirements and will operate just as effectively at positions of partial opening as at full capacity. In recent years, however, dams of such size are being constructed, and the required discharge is in many cases of such magnitude that a single free-discharge regulator will not suffice and a battery of these units becomes necessary. If these are all of approximately the same size and have about the same capacity, only one of them need be a regulator, capable of operating at fractional openings. The remaining valves may all be of a type that is required to function only in the wide-open position, hence they may be of much simpler and less expensive construction than the regulator.

Shape of free-discharge valve bodies and disks now in use differs little from those of butterfly valves in penstock service, although research work now in progress may indicate the desirability of adopting special features permitting the discharging jet to break clear of the valve structure at a sharp edge and to admit air at certain points to prevent the formation of a vacuum and the resulting tendency toward cavitation.

Notable Installations of Butterfly Valves

At the present time, there are no less than ten butterfly valves, up to and including 84 in. in diameter, rendering eminently satisfactory service under free-discharge conditions; some of these operate under heads well in excess of 200 ft. Even under the most severe conditions, vibration is entirely absent and no difficulties have been experienced. Some of these have actually seen use as discharge regulators and have been operated for considerable periods in a position of fractional opening, even though not originally intended for this kind of service. Unless their continued use under these conditions causes cavitation and wear not yet apparent, it seems reasonable to predict that the butterfly type of valve may well fulfill all the requirements for an economical and dependable free-discharge regulator.

Among the butterfly valves now installed and operating under extremely high heads are those built for the Pigeon River Plant of the Carolina Power & Light Co., each 9 ft. in diameter. The normal static head under which they are installed is 836 ft., but in order to take care of possible pressure rise in the penstock, it was considered necessary to design them for a maximum head of approximately 1215 ft. They are located at the lower end of their penstocks, adjacent to turbine casings and the operating mechanism for each of them is of the hydraulic type, consisting of a cylinder and piston actuated by penstock-water pressure that is admitted to the cylinder through an electric-motor-operated control valve. Each butterfly valve is provided with a bypass valve by which the turbine casing below can be primed or filled with pressure water before opening the butterfly disk.

In the Oak Grove Plant of the Portland General Electric Co. on the Clackamas River near Portland, Ore., two 79-in. diameter butterfly valves installed under an operating head of about 940 ft., serve as main inlet valves for large reaction turbine units.

Probably the largest-diameter butterfly valves ever built are those installed at the Conowingo Development of the Susquehanna Power Co., located near Philadelphia. These are each 27 ft. inside diameter and work under a head of 89 ft. At the Calderwood Development of the Knoxville Power Co., where the head is 213 ft. there are three 16-ft. diameter butterfly valves.

In the Diablo Plant of the Seattle City Lighting Department on the Skagit River near Seattle, two 14-ft. diameter valves are being installed under a head of 330 ft. In this case, each of the disks rotates on a vertical axis and both the bodies and the disks are sectionalized. Each disk is equipped with an adjustable bronze seal ring, seating against a stationary bronze seat ring set into the valve body. Operation of the disk is effected by a high-pressure hydraulic cylinder, using oil supplied from a pump driven by an electric motor. Provision is made for automatic closure in case of excess velocity.

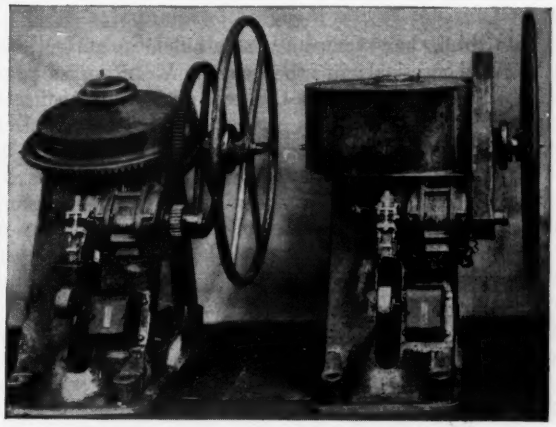


FIG. 3. ELECTRIC MOTOR-DRIVEN OPERATING STANDS

At the Ariel Power House of the Northwestern Electric Co. on the Lewis River near Portland, Ore., a 17-ft. diameter butterfly valve with a horizontal spindle is located at the inlet to the turbine casing where the head is 180 ft. This valve is at the lower end of a large penstock which passes directly through the lower part of the dam, the power house being located adjacent to the dam itself.

A NEW FIXTURE known as the Violite adapter, manufactured by the Westinghouse Electric and Manufacturing Co., makes it possible to obtain dual-purpose lighting, a combination of general interior illumination plus ultra-violet irradiation, easily and economically.

This adapter consists of a socket for a 200-w. ballast lamp and an aluminum reflector and socket for a type G-1 ultra-violite glow lamp. The G-1 lamp is in series with the incandescent or ballast lamp, which acts as a ballast resistance. No transformers or other equipment are necessary.

To install the Violite adapter, it is necessary only to remove the cap at the bottom of a standard 14-in. Sollux globe and screw the adapter into the socket of the regular lighting lamp. The reflector at the bottom of the adapter closes the hole in the bottom of the globe.

It is estimated that a daily exposure to an average installation of this type of Dual-Purpose lighting equipment is equivalent to approximately 15 min. of the rays from a therapeutic floor lamp.

Readers' Conference

Load Control in Industrial Plants

I HAVE just been reading Mr. Ruggles' article on page 935 of the Sept. 15 issue and find it very interesting as well as somewhat surprising. It is surprises like this that make us think occasionally. You think you have everything lined up fine so that it cannot be improved upon and along comes someone who points out a few simple little things and then you feel like kicking yourself for not having thought of them first.

I do think, however, that the problem as stated is a little too theoretical; in other words, Mr. Ruggles provided a "set-up" to prove the need of the load control equipment. His solution is correct only in case the fuel increment of the power cost as made in the plant is more than $0.01 per kw.-hr. This is highly improbable and precludes the possibility of using the exhaust steam for heating and certainly the industrial plant that uses a million and a quarter kilowatt-hours a month must have use for a considerable quantity of heating steam. With coal at $4 a ton, one cent would buy about 5 lb. and at a modest evaporation of 8 lb. per lb. of coal this would mean about a 40 lb. water rate which could be allowed for each kilowatt-hour and still come within a fuel charge of 1 cent. Even in a low-pressure noncondensing turbine, I would say that 35 lb. would be a very good figure while with a condensing plant, 20 lb. would be conservative.

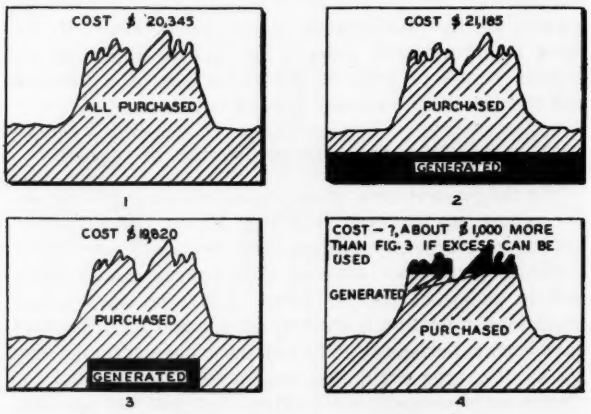
Furthermore, Mr. Ruggles says that the 750-kw. turbine was for vital needs so that it would undoubtedly be considered necessary to keep it hot all the time and have a crew on duty. Undoubtedly a condensing machine would be installed under the circumstances, unless it was intended to have the turbine run noncondensing and supply heating or process steam for which it should be credited and this would pull the fuel cost down to at least ½ cent per kw-hr.

Now there are four and not two ways that the plant could be operated as shown in sketches 1, 2, 3, and 4. The first and simplest would be to buy all the power which would cost as shown by Fig. 1.

Demand Charge		
100 × 2.50 =	250.00	
3400 × 2.00 =	6,800.00	
	7,050.00	7,050.00
Energy Charge		
10,000 × .02 =	200.00	
1,309,500 × .01 =	13,095.00	
	13,295.00	13,295.00
		20,345.00

As the turbine is a vital need and it is run or kept hot all the time, there would be a further charge for the industrial plant which we can assume to be 1.5 cents per kw-hr. when the turbine is run full load 24 hr. a day although the makeup of the 1.5 cent charge is indefinite in the original article. Running the turbine as in Fig. 2, which is the same as Mr. Ruggles' Case I, would increase the cost to $21,185 per mo. as calculated in his article. An increase of almost a thousand dollars a month which we must assume is justified by the vital need.

It is obvious that with this vital need existing, operation of the plant turbine as in Fig. 3 would reduce the plant charges only by the fuel cost of the 468,000 — 79,000 = 389,000 kw-hr. dropped from the plant turbine (There is a negligible discrepancy of 500 kw-hr. between Case I and II on page 936). Apparently this is all that was considered by him because this decrease of 389,000 kw-hr. saved $7020 — $1351.50 = $5668.50. Dropping the balance of the 79,000 kw-hr. at the same rate would leave a cost of only about $100 and with the natural



FOUR METHODS OF OPERATING THE PLANT

increase of heat rate with the low loads this $100 would disappear. If he does consider labor in his costs, his calculations for Cases I and II are obviously wrong.

Of course it is possible that the vital need is not so vital as it seems and the plant turbine could be shut down during the night and thus cut the labor cost and still be able to keep the demand charge down. In this case, the turbine could be operated as in Fig. 3 or as in Fig. 4, which is the same as his Case II. In Fig. 3, the small turbine carries full load for 10 hr. and with the exception of a little coal for banking, the labor, fuel and maintenance work may be considered to vary directly with the time operated so that the cost would still be 1.5 ct. per kw-hr. and the machine would generate 10/24 of 468,000 kw-hr. or 195,000. The difference in cost over Fig. 2 will be the saving of 1.5 — 1 or 0.5 cent per kw-hr. on the load dropped from the turbine that is 468,000 — 195,000 = 273,000 which is $1365 giving a net cost of $19,820.

But it is impossible to concede that operation as in Fig. 4 as he recommends will save anything over Fig. 3. Labor and operating charges will be the same for the plant turbine whether operation is as in Fig. 3 or 4 while the boiler efficiency ranging up and down from zero to full load is bound to suffer and run the fuel costs up for the lighter unsteady load of Fig. 4. If there is a fuel cost of over one cent per kw-hr., as I said before, it will pay to operate as in Fig. 4. But to assume that

the power between 40 and 100 per cent load costs 1 ct. per kw-hr. is preposterous, even assuming an old vertical boiler and noncondensing D valve engine.

Except for the one case in a thousand where this might be true operation, Fig. 4 would cost more than Fig. 3 by the amount (195,000 — 79,000) × (1 — fuel costs per kw-hr. in cts.). If the fuel cost is more than one cent the amount will be negative indicating that the savings operating as in Fig. 3 would be negative, that is it would be more expensive than Fig. 4.

Now, I do not mean that load regulators should not be used because I do not believe that any company buying power should be without a demand limitator or any company operating in parallel with utilities should be without a load regulator but I think the illustration chosen is a very bad one which gives the wrong impression about the proper method of operation. To follow it would cost the average industrial plant from ½ to ¼ a cent for each kilowatt-hour dropped from their own turbine. Furthermore many of them would probably be using the exhaust or bleeding the turbine for heating purposes for which the load would go on quite steadily through the morning, meaning that during the low periods of Fig. 4 live steam would be going into the heating system instead of exhaust which would mean that the load dropped would be costing practically the full energy charge of the power or 1 ct. per kw-hr. in the above case practically $1160 more than Fig. 3 if the exhaust could be used in process or heating.

I think the article is very misleading as it shows where Fig. 4 is the best except under impossible conditions of 4 ct. per kw-hr. whereas it is only in a very exceptional plant that it would show any savings at all.

Brooklyn, N. Y. P. F. Rogers.

Bunker Discharge

It seems to me that the article in the November issue on this subject should have correction on the following points:

Statement that tendency to arch over is greater with steep sides than with flat is controverted by both theory and practice. By theory, lines of arch action exist at every point throughout the material, these lines being practically horizontal over the opening at the foot of the slope and tending to become normal to all sides of the hopper, including the sloping bottom. Departure from normal is limited by the angle of friction of the material sliding on the bunker surfaces. Experience shows that material will run freely down relatively flat plates so long as the hopper is not full nor nearly full. With a full hopper, a wedge of material remains upon the sloping bottom and material above this wedge slides down the steeper slope to leave first. This is in accord with Coulomb's theory and, to say the least, efficiency of the bunker is certainly not increased by giving a flat slope to the bottom.

One of the worst materials for arching over is tempered foundry sand. For this, the best design seems to be to make two sides vertical, the other two sloping at 60 deg.

To give good results, first a hopper should be self cleaning; second the gate should be oversize. Regardless of tendency to arching action in the bin, if the gate be large enough, the bottom will drop out of the arch and it will collapse. I do not feel that movable arms inside the hopper will help; in fact, the less put inside the hopper the better.

I feel that the statement that corner angles in valleys should be as large as possible is also in error.

These statements have behind them not only theory but 9 yr. experience in material handling.

Chicago, Ill. Chesman A. Lee.

Compressed Air Waste

On page 1034 of the October 15 issue of Power Plant Engineering E. O. Edney presented an article on the wastage of compressed air which brought to mind a simple air leak test we used to check up air losses in mining operations. Any section of piping can be tested for leaks provided there are good tight valves on both inlet and outlet, or the whole system can be tested at once. It is much better to test and check up small sec-

FIG. 1

AIR-PIPE TESTS

1 PLACE	2 LOAD	3 LENGTH AND SIZE OF PIPE	4 VOLUME COMP'D. AIR IN PIPE CU.FT.	5 VOLUME FREE AIR LOST CU.FT.	6 TIME TAKEN TO DROP FROM 50 TO 40 LBS.	7 FREE AIR LOST PER MIN. CU.FT.	REMARKS
EAST LEVEL HDWAY. BRANCH SO SINKING		560' OF 8"	108.93	197.64	33 MIN.	5.99	LEAST PREVIOUS 2.71
		860' OF 6"	168.82				
		855' OF 5"	176.54				
		PIPE	CU.FT.	CU.FT.	50/40 LBS.	CU.FT.	
FIG. 2		66.33' OF 3"					
		234.83' OF 2½"					
STEEL SHOP		94.66' OF 2"	13.75	6-875	10 SEC.	41.25	LEAST PREVIOUS 48.73
		21.5' OF 1"					
		83' OF ¾"					

FIGS. 1 AND 2. RECORDS SHOWING LOSS OF AIR IN COMPRESSED AIR LINES

tions at a time. The time required to make these tests is short and one man can attend to them together with other duties.

The method is as follows: Have a pressure gage connected in the line to be tested (the one gage can be shifted from place to place) then close all valves on both inlet and outlet, watch the gage until it drops to 50 lb., then note the exact time it takes the pressure in the pipes to drop from 50 to 40 lb. Divide the volume of air in cu. ft. in the section by 2; this gives the volume of free air lost in cubic feet. Divide volume of air lost by time in minutes taken to drop from 50 to 40 lb.; this gives the loss in cubic feet per minute in this section. It must be understood that to use this method the drop in pressure must be from 50 to 40 lb.

Copies of sheets used in reporting such tests are shown herewith, one from a drill steel sharpening shop which consisted of five air operated sharpening machines and five air blown furnaces; in this case, the loss found was 41 cu. ft. per min. and running 10 hr. a day, this would mean a loss of 24,650 cu. ft. of air every 10 hr., at, say, 4 cents per thousand comes very close to $1.00 a day waste in a section of piping of only 13.75 cu. ft. of pipe volume. Of course it is in the sections of piping that supply the most machines and that have the most valves and fittings that the greatest wastage will be found.

The other sheet (No. 2) is from a section of large pipe and the loss per minute is only 5.99 cu. ft., while the volume is 395.4 cu. ft. This method has been found very useful in testing pipe lines that pass through aban-

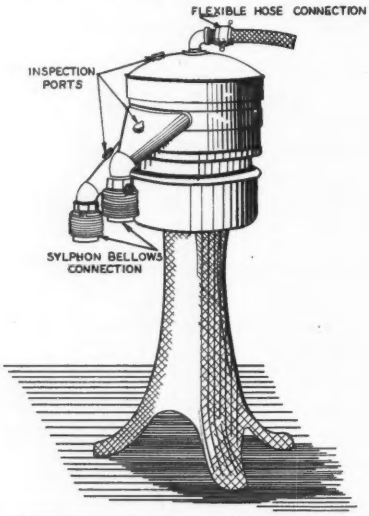
doned working places in mines, or for testing pipe lines that are covered with ground or any other material.

When we recollect that a leak the size of an ordinary pinhole for one year means a wasted investment of $1000, all who are interested in the handling of compressed air should use every means possible to stop such leakage.

J. B. PETRIE

Eliminating Oil Fumes in Oil Purifiers

IN THE December 1, 1931, issue of Power Plant Engineering, on page 1160, Ed Swan described an exhauster for eliminating undesirable fumes sometimes given off by hot oil going to a lubricating oil purifier. Lest our readers get the impression that manufacturers of oil



FUEL OIL PURIFIER WITH VAPOR-TIGHT INLET AND DISCHARGE

purifiers have failed to provide for this condition, we show in the attached sketch the closed inlet and discharge connections that can be provided by one manufacturer. Closed, flexible hose connection is used for the inlet, with sylphon bellows connections on the discharge spouts and inspection ports on receiving cover and spouts. Machines can be equipped either with sylphon bellows or seal cups on the discharge spouts. Connections of these types are recommended for use with materials that give off objectionable or volatile vapors, while special arrangements are furnished for other applications. Unfortunately, the manufacturer does not always have the opportunity to learn under what conditions these purifiers are to operate. Besides this, in many cases the manufacturer's recommendations go unheeded until after the equipment is installed.

Diesel Engine Cooling Water Operation

FOR A 300-hp. Diesel engine, combustion was practically perfect when the engine was pulling a full load but decidedly faulty when the load dropped off one-half. It was suggested that choking down the cooling-water supply when the load fell off would remedy the condition and that proved correct.

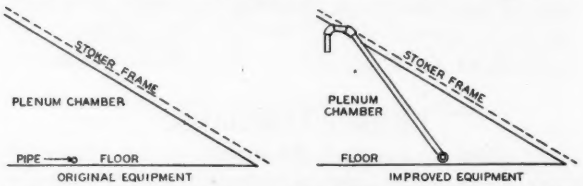
In a Diesel engine, the fuel charge is injected as a spray, ignition being by the high temperature of the air charge, which, with a full load, may be up to 1400 deg. F. This high temperature results from compression of the air and, if the temperature of cylinder walls drops below a certain value, depending chiefly upon the quality of the fuel, ignition of the oil globules cannot occur. At light load the fuel charge is relatively small, the heat generated is decreased and cylinder cooling tends to chill the charge of oil, thus causing difficulty in ignition.

If the flow of cooling water be reduced, so that the temperature and pressure may rise to the highest practicable value, the engine's efficiency is improved. Putting the flow of cooling water under governor control would facilitate this. If the cylinder-wall temperature be held constant, the compression pressure will be steadier. To secure a constant wall temperature, it is necessary to proportion the flow of cooling water to the load. With a light load, the quantity of heat given off by combustion is lessened; consequently, the quantity of cooling water needed is less. Diminishing the flow until the water issuing from the jackets shows a temperature rise of from 10 to 15 deg. will usually suffice.

D. J. ALTIZER.

True Windbox Pressures

AFTER OUR NEW 3500-hp. stokered plant was put in operation, we experienced considerable difficulty with our multipointer gages giving false readings on the windbox pressure scale. The windbox air pipe line led back through the boiler setting to the plenum chamber, i.e., the pipe just entered the plenum chamber. The coal siftings were forever plugging the line up. Our remedy



CHANGING THE PIPING GAVE TRUE PRESSURE READINGS ON THE DRAFT GAGE

was to thread the end of the pipe entering the plenum chamber and place an elbow and pipe cap to the highest front corner of plenum chamber. At the end of the pipe we used a 45-deg. ell, a close nipple, a 90-deg. ell and nipple 4 in. long looking down. This simple apparatus has been in operation for 7 mo. with absolutely no trouble.

Poughkeepsie, N. Y W. E. HELMER.

CLEMENT STUDEBAKER, president of the North American Power and Light Co., has announced appointment of C. A. Leland, jr., vice president and general manager of the Des Moines, Iowa, Electric Light Co., in charge of the Kansas utility properties of the corporation, succeeding Albert Patten, president of the Kansas Power and Light Co., Topeka, Kans., whose death occurred Dec. 14. Mr. Leland will continue supervision of the Iowa properties of the North American and direct the Kansas utilities from his Des Moines office, with Ira Steele, who is assistant manager in Des Moines, as assistant in the Kansas operating position. Prior to his appointment to the Des Moines position Mr. Leland was assistant manager and chief engineer of the Kansas Power and Light Co. and general manager of the United Power and Light Co. in Kansas with offices in Topeka.

Plant Operation Problems

Pipe Size to Fill Water Tank

FOR A 1000-gal. water tank to be filled from a 4-in. main at 56 lb. pressure, a 2000-ft. line of ¾-in. pipe is proposed, with two 90-deg. elbows. Vertical lift is 20 ft. and it is necessary to fill the tank in an hour. Is the ¾-in. pipe large enough? What would be the pressure drop due to friction? What size of pipe is needed to meet the requirements? A. C. L.

A. Computation of flow of water in a pipe is somewhat complicated and is usually performed with the aid of tables of flow and friction pressure.

To show the process, however: Gallons per minute equals 2.83 times the square root of (head in feet, times diameter in inches to the fifth power; divided by the coefficient of friction, times the length in feet).

Pressure of 56 lb. = 130 ft. head, which minus the 20 ft. lift leaves 110 ft. head available to produce flow.

Inside diameter of ¾-in. pipe is 0.824 in. The two elbows will be equivalent to about 4 ft. of pipe, giving a total of 2004 ft. and the coefficient of friction for new clean pipe may be taken as 0.015.

If these values be substituted, we have then the following equation:

$$G.P.M. = 2.83\,[(110 \times 0.824^5) \div (0.015 \times 2004)]^{\frac{1}{2}}$$

and if this is solved, it gives the flow in gallons per minute as 3.334.

To fill a 1000-gal. tank in an hour would require a flow of 16.7 gal. per min. so that it would take about 5 hr. to fill the tank.

Friction loss with a flow of 16.7 g.p.m. in the ¾-in. pipe would be 598 lb. per sq. in. in the 2000 ft. of pipe. Obviously this is quite impossible. The friction pressure drop when carrying 3⅓ gal. per min. would be about 31 lb.

Your available head, 110 ft., gives about 5½ ft. available per 100 ft. of length. From tables of flow, 1¼-in. pipe passing 16.7 gal. per min. would require 6-ft. friction head per 100 ft. of length. For 5½ ft. drop per 100 ft. of length it would pass about 13¼ gal. per min. or it would take an hour and twenty minutes to fill the tank.

With 1½-in. pipe, to pass 16.7 gal. per min. would require about 2.8 ft. drop per 100 ft. length. With 5½-ft. drop per 100 ft. it will pass 21¼ gal. per min. and will fill the tank in about 50 min.

Calculation of Joint for Pressure Vessel

A STEEL PIPE line 8 ft. in diameter is 260 ft. at its lowest point below the surface of the reservoir from which it runs. How thick must be the steel plates at that point, allowing 15,000 lb. per sq. in., unit stress; and what must be the number and size of rivets and type of longitudinal seam; allowing 8000 lb. per sq. in. for shear? (Assume weight of water at 62.5 lb. per cubic foot). J. T. S.

A. In solving your tank problem, it is usual first to assume a joint efficiency which is reasonable for the type of joint you expect to use, then by use of the formula given herewith calculate the plate thickness that will satisfy the conditions. With the thickness of the plate decided the next step is to design a joint which in efficiency will be as high as or higher than the assumed figure. This may require several calculations and assumptions before satisfactory results are obtained. Following this procedure the calculations for your problem are given as follows:

$$t = \text{thickness of plate in inches} = \frac{pd}{2Se}$$

p = unit of pressure, pounds per sq. in. $= 260 \times \frac{62.5}{144} = 112.8$

d = diameter of pipe in inches $= 8 \times 12 = 96$ in.

S = allowable tensile strength of the steel = 15,000

e = efficiency of the joint expressed as a fraction = 0.55 (assumed).

$$t = \frac{112.8 \times 96}{2 \times 15{,}000 \times 0.55} = 0.656 \text{ in. or } 11/16 \text{ in.} = 0.688 \text{ in.}$$

Then calculating the joint efficiency for various P, d and a values with 11/16 in. plates we find the pitch of 3 in., diameter of 1¼ in. for rivets satisfies our assumed conditions.

Our calculations indicate, therefore, that the plate should be 11/16 in. thick, the joint should be a double riveted lap type, with rivets spaced 3 in. on centers and 1.25 in diameter.

Proper Illumination for Drafting Room

A DRAFTING ROOM 18 ft. x 30 ft. is to be lighted by indirect system. Determine the number, type and size of electric lights to be used.

A. For semi and totally indirect units, the permissible spacing distance between outlets is 13½ ft.; the permissible spacing distance between outlet and side walls is 4½ ft.; the suspension distance ceiling to top of reflector is 2¼ ft.

$$A = \text{Area in sq. ft. per outlet} = \frac{\text{total floor area}}{\text{No. of outlets}} = \frac{540}{6} = 90.$$

$$B = \text{Lamp lumens required per sq. ft.} = \frac{\text{foot-candles x depreciation factor}}{\text{coefficient of utilization}} = \frac{15 \times 1.3}{0.25} = 0.78.$$

15 is the recommended illumination for drafting room.

1.3 is the depreciation factor for fairly clean locations.

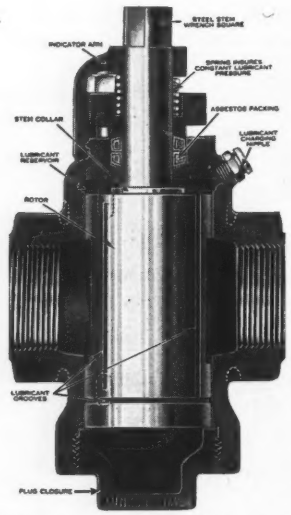
0.25 is the utilization coefficient for a room 30 by 18 with this type lighting.

Lamp lumens required per outlet = A x B = 90 x 0.78 = 0.702; thus 75 watt type C mazda lamps should be used.

New Equipment

Slaset Lubricated Rotor Valve

IN THIS VALVE, which has a straight-bored body and cylindrical rotor, lubricant is forced into the reservoir above the closed top of the rotor, the pressure forcing the rotor down as the reservoir fills. Pipe line pressure, aided by an ex-



SECTION OF SLASET ROTOR VALVE

ternal spring, causes the rotor to act as a booster plunger, which forces the lubricant into pockets in the body and grooves in the rotor, whence it is distributed to form a protecting lubricant film for the bearing surfaces, as well as a seal when the valve is closed.

When the valve is operated, the sealing groove which passes the port has no contact with the lubricant reservoir, hence lubricant is consumed only during opening and closing of the valve to replenish the sealing film on the bearing surfaces.

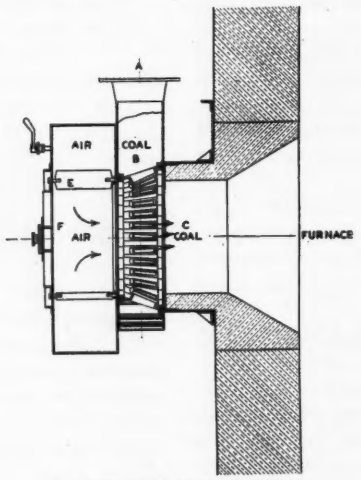
Attached to the stem is an indicator arm which acts as a positive open and closed stop, plainly shows whether the valve is open or closed and indicates the relative amount of lubricant in the reservoir.

Since the steel stem and the rotor are not integral, the rotor seats without binding or cocking, even though the packing may be compressed unevenly around the stem. This aids tight closure, as pressure in the line holds the rotor against the outlet port without any interference from the stem.

The Slaset valve is a single-acting valve with screw ends for 150 lb. and flange ends for 125 lb. gas or liquid pressure at 150 deg. F. It is covered by patents owned by the makers, The Lunkenheimer Co., Cincinnati, Ohio.

Riley Cyclone Burner

SUCCESS of the Riley Cyclone Burner, which was developed to permit high coal rates per burner is indicated by the fact that at the W. Va. Pulp and Paper Co. one burner has burned sufficient coal to produce 135,000 lb. of steam per



RILEY CYCLONE BURNER

hour without having reached the capacity of the burner. This rate of steam generation from one burner at this plant means a liberation rate of over 205,000,000 B.t.u.

Flange A is connected to the coal discharge pipe from the pulverizer. Coal travels into the burner into space B and out ports C. Secondary air after passing through a damper passes through vanes E thereby receiving a violent whirling motion, thence into space F and the furnace. Intense turbulence and positive mixing of coal and air result from the whirling circular motion of the secondary air striking the uniform multiple number of coal streams travelling in the line of the burner axis, thus giving high coal burning rates with a comparatively short flame.

Elevator Lubrication

LUBRICATING AN ELEVATOR has developed to the point where an oiler must be almost a graduate mechanical engineer. According to the Otis Elevator Co., twenty-nine different types of lubricants are required to operate various types of the modern elevators now in use.

Efficient lubrication is one of the most important factors in the care of elevator equipment so that vertical transportation may function in the manner expected of it by its millions of passengers.

The company buys the various bases for the oils and compounds many of its own lubricants in a plant at Harrison, New Jersey. These oils and greases are then packed in containers and drums, with full directions as to the specific uses for which they were prepared.

The oil used in the lubrication of the worm gear of an elevator is considered by the company as the most important of its lubricants.

Another lubricant which is difficult to prepare correctly is that used in the door checks of elevators having doors which open and close automatically. This might be called a temperamental oil. In order to act as a buffer, it must have body; it must be noncorrosive, so that the cylinders will not clog up and fail to work; it must not evaporate or be sensible to change in temperature.

RECENTLY Coppus Engineering Corp. of Worcester, Mass., has brought out a Cable Manhole Ventilator Blower with capacity of 950 c.f.m. free air. This unit includes a Vano Blower driven by a ¼-hp., 110 or 220-v. universal motor mounted by vertical swivel on a handy tripod and with flexible canvas air tube, to be attached to the diffuser to direct the air where desired. It is for ventilating cable manholes, sewers under construction, shipholds, tanks, silos and coal bins, or confined spaces in chemical plants and oil refineries.

St. Denis Station to Operate at 880 Deg. F.

AT ST. DENIS, France, a large high-pressure station is at present under construction, under management of the Societe D'Electricite de Paris.

When completed, the new station will contain a total of seven turbo-generators and fourteen steam boilers, but the present installation consists of three turbo-generators and six boilers. It is intended that each group of one turbo-generator and two boilers shall form a unit, two units being normally in operation while the third one is in reserve. Each turbo-generator is rated at 50,000-kw. capacity and will operate at approximately 780 lb. per sq. in. steam pressure.

Each boiler is of B. & W. make, fired with pulverized coal from unit mills and equipped with Bailey water walls, superheater, economizer and air preheater. The boiler operating pressure is approximately 1000 lb. per sq. in. and the maximum capacity is 265,000 lb. of steam per hour. Steam temperature is to be unusually high, being 880 deg. F. normally but running as high as 935 deg. F.

Early in 1932, complete systems of Bailey automatic combustion control and three-element feedwater control will be installed in the St. Denis Station.

Control of the air supply to the furnace will be effected by connecting Bailey control drives to dampers and to the brush shifting mechanisms of the fans, of which there are two for induced draft and two for forced draft in each case. The rate of fuel supply will be regulated by controlling the coal feeder speed. Furnace draft will be controlled also but instead of being held constant, it will be varied slightly with the boiler rating.

For each group of two steam generators, there are three feedwater pumps of which one, turbine driven, will have a capacity of 550,000 lb. per hour and the other two, motor driven, will have a capacity of 300,000 lb. per hour each. All these pumps will work in parallel.

The pumps take water from a header supplied by hot wells under pressure, which, in turn, are supplied with deaerated and preheated condensate. From the pumps the water flows through the high-pressure preheaters whence it passes to the economizers, the automatic regulation being carried out by the Bailey three-element feed water control system.

There will be a central control panel on which will be mounted two 12-in. diameter pressure indicators which can be connected to any one of the three separate drums into which the steam boilers feed and which are situated at the turbine inlet. A series of valves will be provided for this purpose. Two master steam pressure panels, each containing a master pressure recorder, can likewise be connected to any one of the three units.

An individual boiler control panel will be supplied for each group of two boilers and will contain the following Bailey equipment: 2 boiler meters with steam temperature and pressure recorders and feedwater temperature compensators; 2 feedwater meters with water level recorders forming part of the Bailey three-element feedwater control; 2 10-pointer multipointer gages for indicating air pressures and drafts; 2 position indicators and alarms for the three-element control.

ORDER for 1.5 mi. of belt conveyors was received by the Stearns Conveyor Co. of Cleveland, a subsidiary of the Chain Belt Co., Milwaukee, for construction work on the Hoover Dam.

Standing Committee on Water Analysis

REFERENCE has been made in the reports of the Executive Committee of the American Society for Testing Materials and of Committee E-10 on Standards to the organization of a new standing committee of the Society the function of which would be the development of standard methods of water analysis. It is now proposed to proceed with the organization of such a committee and Max Hecht, Chief Chemist, Duquense Light Co., Pittsburgh, has been designated by the Executive Committee as temporary chairman. The Society has been interested for some years in the Joint Committee on Boiler Feed Water Studies, on which the Society has been represented by Mr. Hecht and F. N. Speller. The methods to which the new standing committee will give consideration would be of interest not only in connection with boiler feed water and also with all types of industrial waters. Schematic diagram gives an idea of the work.

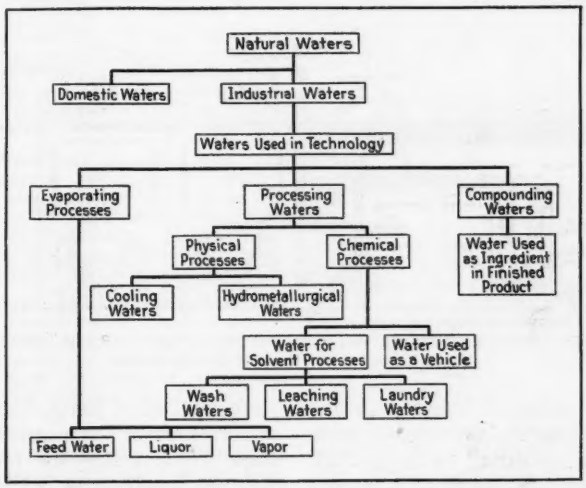
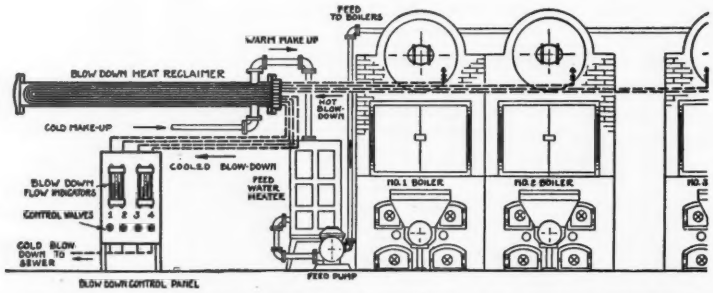


DIAGRAM OF PROPOSED WORK FOR WATER ANALYSIS COMMITTEE.

It is proposed to organize with a relatively small group in the initial stages of getting the work of this committee under way. The committee will no doubt be augmented at a later date. Those interested in the work of this proposed committee should communicate with the Secretary-Treasurer, C. L. Warwick, American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa.

Precision Control of Continuous Blowdown

ACCURATE concentration control in boiler water requires that the blowdown be accurately controlled, or concentration will not be properly maintained, while blowdown losses likewise the cost of water treatment may be much increased. To meet this condition simply and at low cost the Elgin Softener Corp. has recently brought out for its continuous blow-down system the Eckel Precision Control, acting after water has been cooled, thus avoiding flashing of blowdown water into steam with subsequent erosion.



ELGIN CONTINUOUS BLOWDOWN SYSTEM AND ECKEL PRECISION CONTROL SERVING FOUR BOILERS

Any number of boilers can use the same heat reclaimer, each being controlled according to its individual requirements, so that its concentration is regulated with precision regardless of the fluctuations of the load.

Control of blowdown according to the rate of feed may lead to varying concentration, as when increase in feed is largely condensate requiring no added blowdown, or a less feed all of make up, requires considerable increase in blowdown.

For the Eckel control a black steel panel is provided, with flow gage and hand-operated valve of forged steel with nitralloy seats and discs for each boiler, permitting blowdown from each boiler to be regulated according to gage indications. Each gage of rust-resistant steel indicates blowdown flow from its boiler in gallons per minute.

Blowdown line, usually ¾ or 1-in. size, with a valve close to the boiler for shut-off purposes, is brought out from each boiler and carried direct to the heat reclaimer. Blowdown water passes into the heat reclaimer without negligible throttling, through ample area for correct velocity and distance of travel to abstract maximum heat, thence to pipes at the rear of the panel and through individual control valves and orifices to the discharge line. Because of the high rate of heat transfer to feed or make-up water, blowdown entering the heat reclaimer at a temperature of 400 deg. F. will discharge to the sewer at a temperature within 10 deg. of cold water.

The Elgin counter-flow heat reclaimer consists of a seamless steel pipe of capacity and strength for the conditions to be encountered. Tubes are of hard drawn seamless copper, the tube sheets of bronze or steel. The tube bundle, dividing plate and other parts slide in and are supported by a grooved steel track which makes the removal of the tube bundle easy, while providing a sealed baffle and a distributed support for the tubes.

Pilot-Operated Liquid Level Controller

INSTRUMENT TYPE liquid level controller is now being marketed by Neilan Co., Ltd., 641 Santa Fe Ave., Los Angeles, Calif. This controller has been developed for controlling the levels of liquids of high gravities. It is also finding application for interface service where the float is required to sink in one level and float in another of a different specific gravity. Through the sensitiveness and other refinements claimed for this new Neilan controller only a 6-in. float is required to provide ample power for maintaining levels in liquids of even the highest gravities. This instrument is of the pilot operated type and may be used to operate a remotely located control valve. These instruments are being used, it is stated, in the liquefied propane and butane service.

E. S. Lee Appointed Head of G. E. Laboratory

EVERETT S. LEE, an assistant engineer of the General Engineering Laboratory of the General Electric Co. at Schenectady, has been appointed engineer of the laboratory to succeed the late Louis T. Robinson. Mr. Lee was graduated from the University of Illinois in 1913 with the degree of B.S. in E.E.; in 1915 Union College awarded him the degree of M.S. He entered "Test" at the General Electric Co. in 1913 and then went to Union College as an instructor in electrical engineering. Following the World War, in which he held a commission as first lieutenant, Mr. Lee entered the General Engineering Laboratory of the company, and in 1928 was made an assistant engineer of the laboratory.

Mr. Lee was formerly chairman of the Schenectady section of the American Institute of Electrical Engineers, and at present is a member of two national committees of the institute. He is chairman of the sections committee, and a member of the instruments and measurements committee. He is a member of Tau Beta Pi, Eta Kappa Nu and Sigma Xi, honorary engineering and scientific societies.

Simultaneous with this appointment is that of Dr. J. J. Smith to succeed Mr. Lee as one of the assistant engineers of the laboratory.

CITY OF FLINT and the City of Saginaw, the latest in car ferries, are Dings equipped. These two new vessels are owned by the Pere Marquette. Each one handles a total of 33 cars and makes two trips a day across Lake Michigan. They are driven by twin electric motors of 3600 hp. each and the boilers are stoker fired.

Tramp iron in the coal is always a source of danger, as it may clog the stoker mechanism and may melt on and jam the grates. To eliminate this risk each of these two boats is equipped with two Dings high intensity magnetic separators, over which all coal is passed.

ACTUAL TOTAL OPERATING time of any electric equipment using alternating current is shown by a time meter introduced by the General Electric Co.

News from the Field

EXTENSIVE EXHIBIT of motor control equipment in Chicago will be held during the four weeks beginning February 1, when the Allen-Bradley Co., Milwaukee, Wis., will display units representing its entire line. The fifth floor of the Engineering Building, at 205 West Wacker Drive, has been reserved for this display. The exhibit will be in charge of Eugene F. LeNoir.

COMBUSTION ENGINEERING CORP. announces the appointment of Charles McDonough as publicity manager, succeeding Carl Stripe, who has resigned. Mr. McDonough has been identified with the company for the past 15 yr., having served as assistant publicity manager for some time prior to his present appointment.

RILEY STOKER CORP., Worcester, Mass., announces that J. H. Rohrer and H. W. Hendrix have been appointed sales engineers and will be located at Philadelphia.

H. BERKLEY HEDGES, for many years district sales manager, New York office of York Heating & Ventilating Corp., now the Carrier-York Corp., has been appointed special representative of Carrier Corp., with headquarters in Newark, N. J.

RELIANCE ELECTRIC & ENGINEERING CO., Cleveland, Ohio, announces the following branch office changes: the Cincinnati office has been moved to 2905 Carew Tower, with J. L. Van Nort in charge. H. A. Holmes has been made salesman in charge of the Toledo office. L. M. Dunning has been transferred to the Cleveland District Office.

THAT HENRY H. TIMKEN, Jr., who has been assistant works manager of the Timken Roller Bearing Co. for the past 2 yr. has been made assistant to the president of the Timken Steel & Tube Co., Canton, Ohio, has been announced by Fred J. Griffiths, president of the company.

BABCOCK & WILCOX CO., 85 Liberty St., New York, N. Y., announces a further consolidation of the resources and facilities of the Babcock & Wilcox and the Fuller Lehigh organizations, effective January 1. The sales offices of the two companies have been combined and all business heretofore carried on separately or jointly by these companies will be done in the name of The Babcock & Wilcox Co. through its district sales offices. This latest consolidation, the company states, is expected to result in a better and more efficient sales service to the customers of both organizations and others with whom the company does business. It also places The Babcock & Wilcox Co. in a vastly better position to give completely co-ordinated sales, engineering and manufacturing service.

AT A MEETING of the board of directors of the Chapman Mfg. Co., Indian Orchard, Mass., held December 23, Thomas F. Maher, formerly vice president and general manager, was elected president of the company, succeeding Adolph W. Gilbert, resigned. Edwin A. Carter was elected vice president of the company and remains chairman of the board.

R. L. SUHL, for the past three years assistant to the late Frederick S. Jordan, succeeds him as manager of the Nickel Sales Department of The International Nickel Co., Inc., 67 Wall St., New York, according to an announcement made by the company today. Ransom Cooper, Jr., Walter C. Kerrigan and Charles McKnight have been appointed as Mr. Suhl's assistants.

WEAVER L. MARSTON, sales manager of The Sharples Specialty Co., Philadelphia, was one of the speakers before the Atlanta meeting of the N. E. L. A. on Dec. 7 and 8, speaking on the Centrifugal Purification of Insulating Oils.

L. H. GILMER CO., Tacony, Philadelphia, Pa., has just concluded the regular annual factory conference. Attending this meeting were over 50 men, comprising field salesmen, engineers and department heads.

FRED MIICK has recently been appointed engineer in charge of sewage treatment plant equipment sold in the Pacific Coast Division territory of Link-Belt Co., 400 Paul Ave., San Francisco, Calif., being transferred from the Philadelphia Plant of the company.

IOWA STATE BOARD of Education announces the organization of the Iowa Institute of Hydraulic Research at the State University of Iowa, Iowa City. This has been organized to afford an agency for the coordination of the talent, facilities and the resources that may be made available at the University of Iowa for undertaking projects of unusual magnitude, scope or complexity in the field of hydrology and hydraulic engineering. The staff is made up of the following: Director, Floyd A. Nagler, Professor Hydraulic Engineering; Associate Directors, David L. Yarnell, Senior Engineer, Bureau of Agricultural Engineering, United States Department of Agriculture, and Martin E. Nelson, Assistant Engineer, St. Paul District, United States Engineer Office. Associate Engineers, Frederic T. Mavis, Associate Professor of Mechanics and Hydraulics, Joseph W. Howe, Assistant Professor of Mechanics and Hydraulics, and J. Stuart Meyers, Research Assistant in Hydraulics. The Consultants are: Sherman M. Woodward, Byron J. Lambert, Arthur C. Trowbridge, George W. Stewart, Henry L. Rietz and Edward Bartow. The advisory committee consists of: Clement C. Williams, Nathan C. Grover, Leroy F. Harza, Robert E. Horton, Ivan E. Houk, Samuel H. McCrory, Arthur E. Morgan and George R. Spaulding.

PYROMETER DIVISION of the Wilson-Maeulen Co., Inc., has merged with The Foxboro Co. This action has followed 25 yr. of close and friendly cooperation between the two companies, and was made wholly in the interest of better service. The entire personnel of the Pyrometer Division of Wilson-Maeulen Co. will be merged with that of The Foxboro Co. All communications should be addressed to Wilson-Maeulen Pyrometer Division, The Foxboro Co., Foxboro, Mass.

BANCROFT GHERARDI, vice president of the American Telephone and Telegraph Co., was re-elected as president of the American Standards Association for 1932 at the Annual Meeting of the Association held in New York on December 9.

Other officers, who were also re-elected, are: Cloyd M. Chapman, consulting engineer, United Engineers and Contractors, Inc., New York, vice president of the American Standards Association and chairman of the ASA Standards Council, and John C. Parker, Brooklyn Edison Co., Brooklyn, N. Y., vice chairman of the Standards Council.

FEB. 15 to 18 a lighting conference will be held at New Orleans under the auspices of the S. W. Division, N. E. L. A. Details can be obtained from M. F. Canning, New Orleans Public Service Co., New Orleans, La.

C. J. PRENDERGAST, manager of Bailey Meter Co's St. Louis office, was fatally injured in a building collapse at Paoli, Ind., November 20.

AMERICAN Water Works Association and Water Works Manufacturers Association will hold their annual national conventions, May 2 to 6, at Memphis, Tenn., and in connection with these will be dedicated the new Sheahan Pumping Station of the Memphis Water Works, completing a capacity of 45,000,000 gal. a day pumped from artesian wells.

ON FEB. 18, at 8 p. m., the New York District of the A. S. T. M. will hold a meeting at 29 W. 39th St. on the properties and tests of metals for various services with papers by Dr. F. O. Clements, Technical Director, General Motors Research Laboratories, and Professor H. F. Moore of the University of Illinois. Ten different tests of welds will be demonstrated by representatives from Union Carbide and Carbon and Air Reduction laboratories.

COMBUSTION ENGINEERING CORP., New York, announces that J. D. Harrison, district manager of the Chicago office from 1922 to 1929, was reappointed to that position effective January 1, with offices in Bankers Building, Adams and Clark Streets, Chicago. Mr. Harrison will succeed Hugh R. Carr, who has been transferred to the sales department of the home office at New York as Manager of Stoker Sales.

NAYLOR-HICKEY CORP., 641 Washington Blvd., Chicago, Ill., announces that it has been appointed an exclusive distributor for insulating cement manufactured by the Eagle-Picher Lead Co. of Chicago, Ill.

ANNOUNCEMENT has been made by H. W. Fuller, vice president in charge of engineering and construction, Byllesby-Engineering and Management Corp., of the appointment of Herbert S. Whiton as chief mechanical engineer of the company. Mr. Whiton has been acting chief mechanical engineer since the retirement in March, 1930, of H. Boyd Brydon. Mr. Whiton attended the public schools at Hingham, Mass, and received the degree of Bachelor of Science in Mechanical Engineering from Harvard University in 1901. He was associated with the Babcock and Wilcox Co. from 1901 to

1903 and in 1905 entered the employ of Stone and Webster as chief engineer of the power station of the Ponce Railway and Light Co. at Ponce, Porto Rico. In 1909 he became associated with the Minneapolis General Electric Co. as superintendent of power, which position he held until June, 1923, when he became assistant chief mechanical engineer of Byllesby Engineering and Management Corp. Mr. Whiton's home is in Evanston, Ill. He is a member of the American Society of Mechanical Engineers, Harvard Engineering Society and the Shawnee Country Club of Wilmette.

WILLIAM E. UMSTATTD, who has been with the Timken organization for 13 yr., during the last 2 yr. of which he has occupied the capacity of factory manager, has been made executive vice president of The Timken Roller Bearing Co., Canton, Ohio.

AT A MEETING of the board of directors of the General Refractories Co., Philadelphia, Pa., held on Monday, December 28, 1931, the following appointments were made: F. L. McManus, vice president in charge of traffic; D. M. Thorpe, vice president in charge of sales; L. Tschirky, vice president and assistant to president.

AT A SPECIAL MEETING of the board of directors of Fisher Governor Co., December 18, at its main office at Marshalltown, Iowa, Jasper H. Fisher, who has been associated with the company since 1912, was elected president and is now active head of the company. Mr. Fisher has, in his 19 yr. with the company, served as secretary, president, and for the past two years as chairman of the board of directors. He has, for the past few years, resided in California, but plans to return his family to Marshalltown in the near future. L. W. Browne, who has been connected with the company for the past 16 yr. and for the past two yr. as president, has resigned as president and member of the board but still retains a stock interest.

ANNIS AIR FILTERS, a dry type for use on the air intakes of compressors and combustion engines, have been taken over by the Coppus Engineering Corp., and added to its line of airhandling products.

NORTHERN EQUIPMENT CO., Erie, Pa., announces the appointment of the Hopton Co., 404 Denison Building, Syracuse, N. Y., as representatives for its equipment.

For the Engineers Library

SYMPOSIUM ON WELDING, published by the American Society for Testing Materials, comprises eleven papers and discussions on processes, material, applications, inspection and testing. It covers newer processes for steel and alloys by gas and electric arc, also types of joints, fusion welding and specifications.

Tests by stethoscope, magnetic action, Xrays, fatigue and impact are treated with discussion of good and bad welds and inspection for detection of faults.

Copies can be had, 152 pages cloth bound, from A. S. T. M. Headquarters, 1315 Spruce St., Philadelphia, Pa. Price $1.75.

INTERSTATE TRANSMISSION OF ELECTRIC POWER, by H. L. Elsbree; published by the Harvard University Press, Cambridge, Mass.; 5½ by 8½ in., cloth, 197 pages; price, $2.50.

To those familiar only with the engineering aspects of long distance transmission and the progress that has been made in the field during the past decade, this analysis of the legal and administrative problems involved when the power is transmitted across state boundaries will be a source of amazement. To those already familiar with such problems, the book is a storehouse of information, reviewing practically every legal case having a bearing on the subject and presenting the evidence in a clear and concise manner. It is in effect a critical review of the conflict of state and federal jurisdiction and conflicting court decisions based largely on precedent set by railway and natural gas cases.

Approximately 15 per cent of the total power generated is subject to interstate commerce rulings and is, therefore, subject to state regulation only as covered by the state jurisdiction over retail rates. Between the limits of what federal commissions may do and what the states may not do lies a zone which will undoubtedly be turned into a political issue. Regulation of security issues is another phase of the same problem. The book outlines the constitutional limits of state commissions, administrative difficulties and ends with a chapter devoted to a discussion and review of the various proposed methods of regulation.

IN A FINELY ARRANGED and printed booklet of 47 pages, V. D. Simons, Inc., Tribune Tower, Chicago, discusses the principles of industrial plant engineering, use of heat and power, special application to the paper and pulp industry, most economical conditions for balancing heat and power requirements, the economics of connecting industrial power plants to the central station network and of so planning the industrial plant as to give lowest cost for power and heat, feeding current to the network when heat demand exceeds power demand and drawing from the network when heat demand is low. Condensing units, with process steam so bled that a minimum of steam goes to the condenser are advocated, to give a heat rate of 4500 to 9000 B.t.u. per kw-hr.

Limitation of development by the cooling water supply available is brought out, also advantages of mine-mouth or waterside stations as against the transmission expense incurred. Various points needing consideration in establishing industrial plants to interchange with central station networks in order to ensure best economy are discussed at length under five classifications of such plants according to conditions to be met.

BULLETIN No 72 of the University of Wisconsin Engineering Experiment Station gives the results of tests on babbitt, roller and ball bearings by Professors Edward R. Maurer and L. E. A. Kelso. It descries the method of testing and shows the effect of bearing load, speed and time on the coefficient of friction, as well as the comparative friction for the three types under like conditions. Copies may be had from the University at Madison, Wis.; price, 50 cents.

THE NATURE OF A GAS, by Leonard B. Loeb; cloth, 154 pages, illustrated, size 6 by 9 in.; John Wiley and Sons, Inc., New York, N. Y., 1931; price, $4.25.

This book meets a clearly defined need that has long existed for a book on electricity and magnetism to bridge the gap between elementary electricity and the modern treatment that requires wide knowledge of specialized phases of higher mathematics. It presupposes little technical knowledge other than that of elementary physics and elementary calculus. In addition to a comprehensive treatment of the ordinary subject matter of electricity and magnetism, it provides an excellent up to date approach to the application of circuit theory to networks, filters and lines. There is an excellent introduction to the subjects of high frequency oscillations, radiation and electromagnetic waves and considerable discussion has been included of the theory of measurements and of laboratory practice.

While the book is designed primarily as a textbook, it has much to recommend it to the graduate engineer and scientist. It is the first of a series of monographs to be published under the auspices of the Committee on Electrical Insulation of the Division of Engineering and Industrial Research of the National Research Council.

MODERN HEATING is the subject of a new 18-page, illustrated, letter-sized bulletin just issued by Warren Webster & Co., Camden, N. J.

NEW SERIES of self-priming centrifugal pumps is announced by The LaBour Co., Inc., 111 Sterling Ave., Elkhart, Ind., in its new Bulletin 37. This new series is of the direct mounted type and the models shown are designed to be more compact than previous LaBour pumps.

POLYPLATE heat exchanger, a surface type heat transfer apparatus for handling water, oil and other liquids, as well as steam air and gases, is described and illustrated in bulletin 12-H—Supplement 1, recently issued by Schutte & Koerting Co., Philadelphia, Pa. The company is also issuing bulletin 6-F, Supplement 1, describing the Rotameter for liquids and gases. The Rotameter is a measuring device designed to indicate at any time the rate of flow in the pipe line in which it is installed.

HOT LIME SODA WATER SOFTENING is discussed in a 24-page well-illustrated bulletin published by The Permutit Co., 440 Fourth Ave., New York.

ADSCO PRODUCTS for steam distribution, including expansion joints, casings, conduits, condensation and steam flow meters and other steam line specialties are completely described and illustrated in a new general catalog No. 31 published by American District Steam Co., North Tonawanda, N. Y.

SILENT CHAIN DRIVE with $\frac{3}{16}$-in. pitch is announced by Link-Belt Co., 515 Holmes Ave., Indianapolis, Ind. It is described in three types—middle guide or side flanged for shafts driven in one direction, duplex where reversed direction or adjustment provision is desired — in folder No. 2160. It is designed for use where positive yet flexible drive is desired for fractional horsepowers.

FORTY-EIGHT different types of mechanical stokers, manufactured by the fourteen member companies of the Stoker Manufacturers Association, are illustrated and described in a new forty-page Condensed Catalog prepared by the Association and now available for distribution. Copies will be sent upon request to W. V. McAllister, secretary, Stoker Manufacturers Association, Foot of Walker St., Detroit, Michigan.

BELT DRIVES with cast iron pulleys and paper pulleys is the subject of bulletin No. 62 just issued by the Engineering Experiment Station, Ohio State University, Columbus, Ohio. This bulletin, by C. A. Norman and C. M. Moffatt, presents a discussion of the apparatus used in making the test, method of presenting the results, efficiency data, transmission of power and discusses influence of contact angle. Many of the results are presented in the form of diagrams and graphs. Bulletin No. 64 issued by this station presents a discussion of relative heat transfer through refractories by A. S. Watts and R. M. King. The price of these bulletins is 50 cents each.

VOGT HOMOWELD is completely discussed and illustrated in a new letter-sized bulletin, W-1, recently issued by Henry Vogt Machine Co., Louisville, Ky. This discusses the characteristics of Homoweld joints made by fusion welding processes developed by the company. It shows microphotographs, of welds, discusses physical properties, test and test specimens, impact and hardness tests, and shows a number of different types of pressure vessels made by this company. The Flo-Flux electrodes used in this process are given considerable description as well as the annealing or stress relieving furnace used in treating the welded vessels. X-ray apparatus used for examining Homowelds is described and some X-ray photographs of welds are presented.

DIRECTED FLEXING as applied to the Badger Self-equalizing Expansion Joint is discussed in a new bulletin by E. B. Badger & Sons Co., 75 Pitts St., Boston, Mass. This gives details of the new design of Badger corrugation with equalizing ring and discusses the advantages of the new Everdur construction.

TANNERGAS and tanks are described in an 8-page Bulletin No. 100-C issued by the Sullivan Machinery Co., 400 No. Michigan Ave., Chicago, Ill.

LUNKENHEIMER Oil Cups and Oiling Devices, including snap lever and high speed oil cups, loose pulley oilers, spring lid oil cups, disc and wiper fittings, sight feed valves and all accessories are completely described and illustrated in a new 16-page catalog, just issued by the Lunkenheimer Co., Cincinnati, Ohio.

PROMAL, a metal for use in machines and parts, such as stampings and forgings is described with its various applications in a data book which may be obtained from J. V. Gault, Link-Belt Co., 200 S. Belmont Ave., Indianapolis, Ind.

NEW VIEWS OF SPACE, MATTER AND TIME, by J. D. Ross; cloth; 394 pages, illustrated; size, 6 by 9 in. Gateway Printing Co., Seattle, Washington, 1931. There have been many books published in recent years on modern scientific conceptions of matter, space and time, but few of them possess the originality that this one does. This volume, according to the author, had its inception in a paper under the title "The Relation of Radiant Energy to Matter, Space and Time" presented before the Seattle branch of the American Institute of Electrical Engineers in 1920. In this paper and in this book which is an elaboration of the paper, Mr. Ross shows that in the ordinary orthodox ideas of the action of light and electromagnetic phenomena, there is much that is inconsistent, and so, in this book he has left the beaten track somewhat and has evolved a radically different explanation of many of the phenomena of light and electricity, one more closely in accord with Maxwell's mathematics.

Many of the conclusions reached are based upon experiments performed by the author in his private laboratory. These in themselves are exceedingly interesting and quite unlike any usually performed. In short, this is an unusual book and regardless of which other works on this subject one may have read, this is worth one's attention. Mr. Ross, by the way, is superintendent and chief engineer of the Seattle Municipal Light and Power System.

ENGINE TYPE alternators are completely described in a recent 24-page bulletin, No. 1153, by Allis-Chalmers Mfg. Co., Milwaukee, Wis. The bulletin shows how these alternators are used, particularly with several installations of Diesel and gas engines.

NEW LINES of air compressors in one, two and four-cylinder types for belt or motor drive and in capacities from 27 to 348 cu. ft. of free air per minute are described and illustrated in bulletins 88-B and 88-C issued by Sullivan Machinery Co., 400 No. Michigan Ave., Chicago, Ill.

GEAR PUMPS for oils and other liquids are completely described and illustrated in a revised edition of bulletin No. 17-A, just issued by Schutte & Koerting Co., Philadelphia, Pa. Complete description is given of this gear pump together with data on sizes and capacities and many illustrations of typical applications in handling fuel oil, lubricating or other thick or viscuous liquids.

BOILER FURNACE linings, walls and arches made of Steel Mixture refractories are described in a recent 32-page bulletin, No. 231, issued by McLeod & Henry Co., Troy, N. Y.

LIQUID LEVEL CONTROLLER or condensate drainer to maintain a constant level of liquid in such equipment as tanks, receivers, piping systems and other pressure vessels or drainage systems, is described in detail in circular No. 835 issued by the Fisher Governor Co., Marshalltown, Iowa. The company is also issuing circular No. 830, giving engineering data, performance curves and construction details of Fisher controller valves.

COMPLETE LINE of Reeves variable speed transmissions is described in catalog No. 99, a new 74-page illustrated letter-sized bulletin just issued by Reeves Pulley Co., Columbus, Ind.

VORTEX CINDER CATCHER is described and illustrated in an eight-page bulletin recently published by Dust Recovery, Inc., 15 Park Row, New York City.

TYPE LS CENTRIFUGAL PUMP, single stage, single suction, enclosed impeller type, in sizes from 1½ to 4 in., for capacities up to 700 g.p.m., is described in bulletin 217 just issued by the Pennsylvania Pump & Compressor Co., Easton, Pa. In another new bulletin the company describes multi-stage, centrifugal pumps class OMS and OMSB designed for pressures up to about 1600 lb. per sq. in.

OHIO COAL INVESTIGATION, Part I, An Economic Study of the use of Hocking Valley Coal with Underfeed Stoker Equipment, by H. M. Faust, has just been issued as bulletin 63 of the Engineering Experiment Station of the Ohio State University. This bulletin covers a series of boiler tests made with coal from the Ohio No. 6 seam in the Hocking Valley District. Copies of the bulletin may be obtained from the Engineering Experiment Station, The Ohio State University, Columbus, Ohio.

HORIZONTAL duplex pumps for modern oil manufacturing processes are described in a recent bulletin D-12-B-3 from the Worthington Pump & Machinery Corp., 2 Park Ave., New York City. This corporation is also issuing the following bulletins: Power Pump, 2-in. stroke, horizontal duplex, enclosed crank case, self oiling, bulletin D-412-S5; Power pump, vertical triplex single acting, instructions and parts list, bulletin D-423-E-10; Centrifugal pump, type LA, single stage volute, bulletin W312-S3A; Centrifugal pump, type LL, single stage volute, bulletin W-312-S9; Centrifugal pump, type UB, two stage volute, bulletin W-318-S3A superseding bulletin W-318-S3; Centrifugal pump, type L, single stage volute, No. 8, bulletin W-312-S2A, superseding W-312-S2; Multi-V-drive for power transmission, bulletin L-400-B1A, superseding L-400-B1. Other bulletins recently published by the company describe and illustrate centrifugal pumps for sump, irrigation and drainage; deep well pumps; air compressors; vertical and horizontal, feather valve type; power pumps, horizontal and vertical and direct acting simplex and duplex pumps.

STOWE STOKER easy link renewal is illustrated and described in a leaflet sent out by the Johnston & Jennings Co., Cleveland, Ohio.

TUBE-TURNS, series 1R of shorter radius and lower in price than previous series are listed and described in Bulletin 1R of Tube-Turns, Inc., Louisville, Ky. Sizes are 2 in. to 12 in.

EDGE MOOR Water Walls and Air Preheaters for use in the setting of any make or type of boilers are fully described and illustrated in a handsome 25-page booklet, Catalog No. 70, issued by Edge Moor Iron Co., Edge Moor, Delaware.

SPECIAL PROTECTIVE COATINGS FOR INDUSTRY is the title of booklet 505 issued by the Wailes Dove-Hermiston Corp., 17 Battery Place, New York City, containing essential data for engineers and others concerned with the prevention of corrosion in various industrial fields.

D F C ATMOSPHERIC Gas Boiler Burners, Type C, which are atmospheric type burners designed expressly to burn either natural or manufactured gas in firing either power or heating boilers and adaptable for oil filled and other industrial furnaces, are completely described and illustrated in bulletin 306, which has just been issued by the Denver Fire Clay Co., Denver, Colo., P. O. Box 1107.

DRYERS in eleven styles and for all types of industrial applications are described and illustrated in a letter-size, 32-page bulletin just issued by The C. O. Bartlett & Snow Co., 6200 Harvard Ave., Cleveland, Ohio.

Power Plant Construction News

Ariz., Phoenix—City Council, Paul E. Lodge, clerk, is said to be planning installation of pumping machinery and auxiliary mechanical equipment in connection with extensions and improvements in municipal waterworks, for which a bond issue of $200,000, is being arranged. Arthur J. Kline is engineer.

Calif., Watsonville—Apple Growers' Cold Storage Co., Beach Road, has plans under way for a cold storage and refrigerating plant addition, to cost about $100,000 with machinery. Hunter & Hudson, 41 Sutter Street, San Francisco, Calif., are mechanical engineers.

Conn., Hartford—Connecticut Light & Power Co., Hartford, is arranging a fund of $3,400,000 for extensions and improvements in power plants and system during 1932, including installation of additional equipment, new transmission lines, etc. Engineering department will be in charge. This is an increase of about $1,000,000, as compared with 1931 budget.

Ind., Newcastle—The City Council has passed a resolution to electrify the Waterworks Plant. Electrically driven pumps with a capacity of 6,000,000 gal. per day, one 300 kw. Diesel engine unit, one 500 kw. Diesel engine unit, four deep well turbine pumps will be installed. Plans have been approved and bids will be called for in the near future. Mr. Nelson Howard is Chief Engineer.

Iowa, Clarinda—Iowa-Nebraska Light & Power Co., Clarinda, is planning extensions and improvements in local steam-operated electric power plant, including installation of additional equipment.

Iowa, Iowa Falls—Central Electric Co., Cedar Rapids, Iowa, has approved plans for an addition to power plant at Iowa Falls, with installation of a 7500-kw. steam turbo-generator and auxiliary equipment. Company engineering department is in charge.

La., Harvey—Continental Can Co., Inc., 1 Pershing Square, New York, plans installation of electric power equipment in proposed new tin can manufacturing plant at Harvey, entire project reported to cost over $90,000. Favrot & Livandais, New Orleans, La., are architects and engineers.

Md., Baltimore—Consolidated Gas, Electric Light & Power Co., Lexington Building, Baltimore, is perfecting plans for an artificial gas storage and distributing system in the vicinity of Cold Spring Lane, Jones Falls Valley, with capacity of 7,000,000 cu. ft., estimated to cost close to $500,000. Company engineering department is in charge.

Mich., Hart—Village Council, Hart, is said to be planning early construction of a municipal electric light and power plant to cost about $50,000, with equipment.

Minn., Foley—Common Council, Foley, is said to be planning installation of a municipal electric light and power plant, and will secure estimates of cost.

Mo., Springfield—Anchor Mfg. Co., North Clay Avenue and Central Street, plans installation of motors and other power equipment in new two-story incubator-manufacturing plant, 75 x 145 ft., to replace a unit recently destroyed by fire, entire project reported to cost over $40,000.

N. Y., Honeywood (Staten Island)—New York & Richmond Gas Co., 691 Bay Street, St. George, S. I., has preliminary plans under way for a new artificial gas plant at Honeywood, estimated to cost about $125,000, with equipment. Company engineering department in charge.

S. D., Newell—Board of City Commissioners is said to be planning a municipal hydroelectric power station at the Belle Fourche reservoir. It is understood that estimates of cost will be arranged at an early date.

Ark., Conway—G. L. and W. P. Bleidt, 425 West Second Street, North Little Rock, Ark., are at head of project to construct and operate an ice-manufacturing plant at Conway, where site has been acquired, with initial capacity of about 20 tons per day, estimated to cost about $35,000, with equipment.

Calif., Los Angeles—Chrysler Corporation, 341 Massachusetts Avenue, Detroit, Mich., plans installation of electric power equipment in proposed new automobile assembling plant at Los Angeles, entire project to cost close to $1,500,000.

Calif., Monterey — Monterey Peninsula Packing Co., Monterey, plans installation of electric power equipment in proposed vegetable canning plant, to cost over $100,000.

Ill., Aurora—Consumers Co., 464 North Broadway, will soon begin superstructure for a one-story ice plant, 55x165 ft., reported to cost over $35,000, with equipment.

Ill., Moline—Board of Public Works is said to be planning installation of pumping machinery and auxiliary equipment, purification equipment, etc., in connection with extensions and improvements in municipal waterworks, entire program reported to cost over $300,000. Pierce, Greeley & Hansen, 6 North Michigan Avenue, Chicago, Ill., are engineers.

Ind., Winchester—City Council contemplates installation of pumping machinery and auxiliary equipment in connection with proposed sewage disposal plant, estimated to cost $75,000.

Iowa, Cedar Rapids—Penick & Ford, Ltd., Cedar Rapids, plans installation of electric power equipment in new two-story addition to food products plant, to be used for the production of dextrine, entire project reported to cost over $100,000. Adolph W. H. Lenders is general manager.

Iowa, Grand Junction—City Council is said to be planning installation of a municipal electric light plant to cost about $85,000. J. H. Watts is city clerk.

La., New Orleans—United States Oil Refining Co., care of F. W. Leahy Engineering Co., 169 Tchoupitoulas Street, New Orleans, engineer, plans installation of power equipment in connection with extensions and improvements in oil refining plant at Southport, near New Orleans, entire project reported to cost close to $100,000.

Me., Eastport—MacNichol Packing Co., Eastport, plans installation of electric power equipment in connection with proposed rebuilding of portion of fish packing plant, recently destroyed by fire with loss reported over $100,000.

Mich., Detroit—Peninsula Metal Products Corporation, 6635 East Forest Street, plans installation of electric power equipment in connection with proposed rebuilding of portion of plant, recently destroyed by fire with loss reported over $75,000.

Minn., Meadowlands—Meadowlands Power & Light Co. has plans under way for new power plant, reported to cost over $40,000, with equipment. G. A. Dahlberg is manager.

Minn., St. Paul—National Battery Co., St. Paul, plans installation of electric power equipment in proposed branch plant for manufacture of storage batteries at Winnipeg, Man., entire project reported to cost over $80,000.

N. Y., Middletown—New York, Ontario & Western Railway Co., 370 Lexington Avenue, New York, plans installation of electric power equipment in connection with proposed rebuilding of car repair shops at Middletown, recently destroyed by fire with loss reported close to $250,000.

Ohio, Wilber—Lancaster Coal & Sand Co., Wilber, is said to be planning installation of electric motors and other power equipment in connection with proposed rebuilding of local plant, recently destroyed by fire with loss reported at more than $100,000. T. E. Hummel is superintendent.

Pa., Homestead—United States Steel Corporation, 71 Broadway, New York, plans installation of electric power equipment in connection with an expansion program at its steel mills at Homestead. Work is scheduled to begin in the spring, and reported to cost over $500,000. Company will also carry out expansion at its Edgar Thompson plant in the same district.

Texas, Odessa—Texas Potash Co., Dallas, plans installation of electric power equipment in proposed new potash refining plant at Odessa, entire project reported to cost close to $1,000,000. A power house is planned.

Texas, Orange—Commercial Pulp & Paper Co. recently organized, has taken over local plant of Yellow Pine Paper Mill Co., and plans installation of electric power equipment in connection with an expansion and improvement program, estimated to cost over $100,000. C. A. Keiren is company engineer.

Vt., Proctor—Vermont Marble Co., Proctor, plans installation of electric motors and other power equipment in new finishing shop now under way, entire project reported to cost over $70,000.

W. Va., Fairmont—Owens-Illinois Glass Co., 965 Wall Street, Toledo, Ohio, plans installation of power equipment in connection with an expansion and improvement program at local glass plant, to include construction of a new mechanical shop. Entire project reported to cost over $75,000.

Wis., Lake Geneva—City Council plans extensions in municipal electric lighting plant and transmission system. A bond issue is being arranged. Frank A. Briegel is city clerk.